SCHOOL SCIENCE
AND
MATHEMATICS

VOL. LII APRIL, 1952 WHOLE NO. 456

RAIN DROP IMPACT PATTERNS

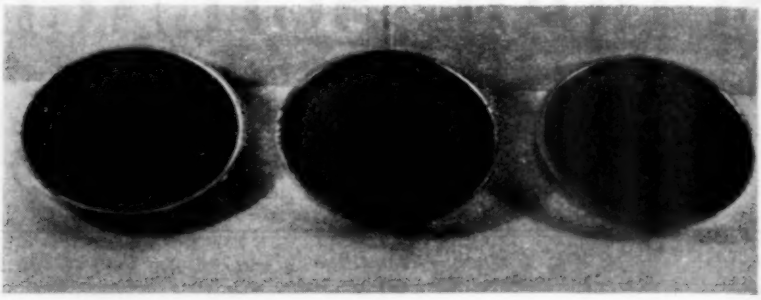
H. SEYMOUR FOWLER
Southern Oregon College of Education, Ashland, Ore.

Many of us have noticed the impact patterns from rain drops which have fallen on dusty surfaces. Some individuals who are especially adept at photography have been able to photograph the impact of the rain drop with the soil and the resulting splash. In public schools there are probably few persons who would be able to duplicate the photograph. However there is no reason to believe that there are any of us who could not make a study of the rain drop patterns. All that is needed to do this is sand, some inexpensive cake tins and falling rain. A few holes should be punched in the pans to provide drainage. The pans with sand should be placed in different locations. Take advantage of different types of cover and place the pans under various trees, shrubs and weeds. Then notice the patterns of rain drops in the different locations. An interesting game may be devised in which the contestant attempts to identify the location of the various pans with their patterns.

An example of rain drop patterns is given below (Figure 1). These patterns were made on August 24, 1950 near Ithaca, New York. The rain drops which produced these patterns continued for about 24 hours. The pan marked A was located under a large maple tree which was approximately 40 feet tall. Pan B was "out in the open" in a location devoid of cover. Pan C had been placed under a grove of staghorn sumacs which averaged 10 to 15 feet in height.

If these patterns are examined closely one notices first that the impacts under the large tree, (A), were fewer but apparently stronger than those "out in the open," (B). The impacts of the rain drops appear to be more numerous "out in the open," (B), than those under

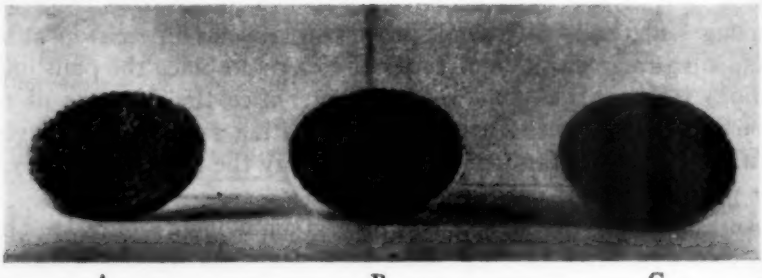
the sumacs, (C). However the impacts from the rain drops under the sumacs, (C), are much stronger than those "out in the open," (B). Finding the "why" in each of these cases would make for an interesting class time discussion.



A B C

FIG. 1. Rain drop impact patterns. These rain drop patterns were made in three different locations. A, Under a Large Tree; B, "Out in the Open"; C, Under Sumacs. These patterns were formed by rain of 24 hours duration on August 29, 1950.

The impact patterns may be preserved very easily. One needs merely to mix gauging plaster and water to a consistency of heavy cream. Then carefully pour the mixture into the pan over the sand until the sand is covered to a depth of $\frac{1}{2}''$. The plaster is allowed to set and then is removed by bending the sides of the pans slightly to loosen the cast. The cast is then washed and may be saved for future reference. A photograph shows casts of the rain drop patterns illustrated in Figure 1.



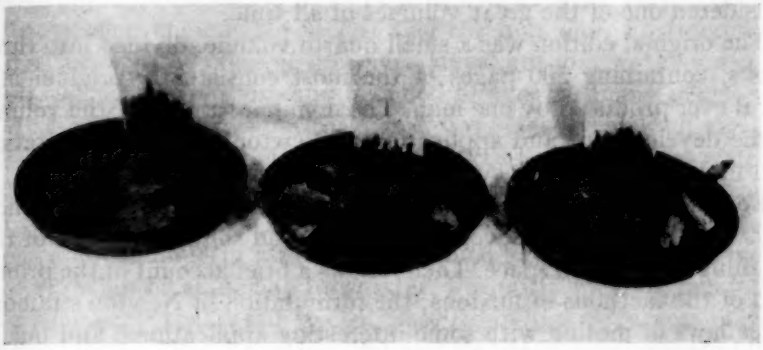
A B C

FIG. 2. Plaster casts of rain drop impact patterns shown in Figure 1.

The pans may be equipped with $3'' \times 5''$ cards to illustrate the splash caused by the falling rain drops. One need merely attach strips of metal with dimensions, $1'' \times 3''$, to the inner portion of the vertical sides of the pans. These strips of metal are held in place with rivets. Next, two holes are punched in the metal strips and the cards

are attached to the metal strips by sewing through one hole, then through the card and up through the card and the second hole in the metal strip. This sewing process is continued until the card is securely attached to the vertical metal strip.

Interesting splash patterns may be observed on the cards after a rainfall. Figure 3 represents one such case. The three pans were placed in the same locations as those in Figures 1 and 2. The reader



A B C

FIG. 3. Rain drop splash pattern after steady rainfall of 24 hours' duration. This pattern was made in early fall after the leaves had fallen. Note the difference in height of splash in the three areas. A, Under a Large Tree; B, "Out in the Open"; C, Under Sumacs. September 16, 1950.

can notice that the spash in the location under the large tree, (A) was much greater than was the splash in either other location, (B) or (C). However the splash under the sumacs, (C), was much greater than that "out in the open," (B).

Here are some interesting activities for inclusion in your science courses. The results of your experiments should provide you with some excellent illustrations of principles and concepts from both the physical sciences and from the biological sciences. In addition, the application of these experiments to the teaching of conservation are numerous.

AN IMPORTANT DECLARATION

On December 20, 1951, the National Association of Manufacturers announced the unanimous adoption by its 160-member board of directors of a Resolution on Support of Educational Institutions which declared that:

"*Business enterprises must find a way to support the whole educational program—effectively, regulary and now.*"

In the context of the discussions in the association's Educational Advisory Committee and Educational Advisory Council which preceded the board's formal action, this declaration represented a bold new approach by the association to the question of financing education.

NEWTON AND HIS "PRINCIPIA MATHEMATICA"

WILLIAM A. GAGER
University of Florida, Gainesville, Fla.

Principia Mathematica or what is better known as Sir Isaac Newton's *Mathematical Principles of Natural Philosophy* has long been considered one of the great volumes of all time.

The original edition was a small quarto volume, divided into three books, containing 500 pages of the most consistently original material ever produced by one man. The dominant theme of the volume is the development and application of Newton's laws of gravitation and motion to the solar system.

Book I is primarily a record of Newton's discoveries in dynamics. This book begins with several definitions and some discussion of the meaning of time and space. Then follows a brief account of the principles of the methods of fluxions; the formulation of Newton's famous three laws of motion with some interesting applications; and finally a consideration of the motion of a body with respect to a fixed point or with respect to another body, in which the author freely and expertly applied his gravitational theory.

Book II of the *Principia* discusses the motion of bodies in resisting media. Newton believed that a body moving in a medium would be resisted in some manner by the medium. First, he predicted that the resistance would be proportional to the velocity; later, he thought the resistance would be proportional to the square of the velocity; and, ultimately, he decided the resistance should be considered in two parts, one of which should be proportional to the velocity and the other to the square of the velocity. It is easy for many people to see how these contributions on the motion of bodies in resisting media have aided tremendously in our modern studies of air resistance in connection with aeronautics.

One who reads Books I and II, carefully enough to get the gist of Newton's arguments and developments, would very naturally expect something further from this master thinker. Book III is Newton's answer; it is the grand finale; it is the mathematical treatment of what Newton calls the "System of the World." It is impossible to picture adequately in a few minutes' time the far reaching consequences of this final book of the *Principia* other than to say that Newton by use of his law of universal gravitation and his astronomical and dynamical discoveries finally made understandable to his contemporaries, and to future generations, the neat order in which bodies moved in the solar system. And further, by reducing the concept of motion to exact calculation, he was able to produce convincing proof

as to how tides were caused, how the mass of the sun could be calculated, and why the earth was not perfectly round.

On the assumption that behind a great book must exist a great personality, it is interesting to see how Newton attained to this greatness.

He was born on a good day, Christmas 1642, but got off to an awfully poor start. Newton was prematurely born. He entered this world weighting approximately three pounds and showing very little signs of possessing enough life to last out the first day. Fortunately he came through the crisis of those first days, but in a weakened condition which bothered him and his good mother for many years.

It is interesting to note that, as a boy, Newton was all the time busy in making mechanical gadgets. He constructed clocks which he operated by water power, special kites with paper lanterns attached to them which he flew at night and excited the superstitious neighbors, and windmills in which he imprisoned mice to furnish his motive power. What he made had to work or, within the limits of possibility, Newton kept at it until it did. Because of the cleverness of these many gadgets he was considered a boy genius along mechanical lines, but as a scholar he was quite widely known to be pretty dull.

Because of his delicate physical condition Newton was more apt to be found reading, a hobby that he thoroughly enjoyed and evidently profited from, than involved in the rough-and-tumble games of the boys. As one would expect, this aloofness caused some of his classmates to take advantage of his physical shyness. The story goes that one day the scholastic leader of Newton's class took it upon himself, without cause or justification, to give Isaac a good swift kick. To the complete surprise of everyone Newton turned on this bully and gave him a first-class thrashing which he climaxed by scraping the fellow's nose back and forth on a stone wall.

It seems like pure speculation to predict just what the beating of the bully did to Newton, just like it is pure speculation to predict why a boy often appears to change completely over night. However, this much can be said: immediately following the "battle with the bully" Newton, for the first time in his life, began to show evidence of scholastic ability and before the school year ended he was not only the best student in his class but the best one in the school.

It was most fortunate that Newton's mother was a very gifted and sensible woman because he had to depend entirely upon her for guidance—his father having died just before his birth. But she made one big mistake which she later had to admit and correct. She decided that Isaac would make a better farmer than anything else so she took him out of the Grantham school and brought him home to Woolsthorpe to teach him the science of farming. Newton loved the old

home farm but his mind kept so occupied with mechanical ideas that he never could see the farm duties that were to be done. For example, during a heavy wind storm, when he should have been caring for the stock and securing the farm buildings, Newton was out in the field jumping with the wind and measuring, and then jumping against the wind and measuring. Why all this jumping? He was trying to get data to enable him to calculate the velocity of the wind. When he wasn't experimenting, he was most apt to be reading while the farm work went undone. After three years of such doings, Mrs. Newton clearly saw that Isaac would never make a farmer so she released him from any further farm obligations.

Upon the advice of his uncle and his old school masters, Newton entered Trinity College of Cambridge University at the age of 19. When he entered Cambridge he knew about as much about what he wanted to do as the average freshman at the University of Florida and that was not enough. He was, however, concerned with making the most of his opportunities so he made up his mind to study hard and let his future take care of itself. The very fact that this procedure worked out so well for Newton might be of some encouragement to students today who cannot make up their minds what their life objectives should be.

At Cambridge Newton soon learned, like many present-day University freshmen have learned, that it didn't usually pay to make snap judgments. A case in point was his reaction to Euclid's *Elements*. After one careless reading of the *Elements*, Newton decided that the theorems were self-evident, and childish, and that he wanted nothing more to do with them. It took no less a man than that great Cambridge Mathematician, Professor Barrow, to convince Newton that he was entirely wrong in his conclusion—that the trouble was not with Euclid's *Elements* but with his (Newton's) truly appalling deficiency in geometry. This sharp criticism from a man whom he highly respected sent Newton back to Euclid's *Geometry* with a keenly analytical method of approach. This time he really became interested and so thoroughly mastered the "Elements" that when he later wrote the *Principia* he expounded his mathematical laws by means of geometric methods. This does not mean that Newton did not make use of his calculus to discover the results recorded in the *Principia* but, after having done so, he took the results obtained by calculus and expressed them in geometric form so that the readers of the *Principia* might more readily grasp his developments. Thus we see the Euclid's *Elements*, which Newton at first despised and rejected, later became the very backbone of his greatest contribution.

The mention of Newton's name is most apt to bring to mind the falling of an apple to the ground. Because of the Great Plague raging

in Cambridge, Newton was apparently just day-dreaming in the garden of his home in Woolsthorpe when the incident in question occurred. One wonders why this particular apple falling on a summer day before the eyes of a leisurely-minded 23 year-old Newton, who had just received his Bachelor of Arts degree from Cambridge, should start any special train of thoughts in his mind. But it did. He wondered why the apple did not move horizontally or in some other direction instead of down. He wondered if the pull on the apple that brought it down to earth would be as great in a valley as it would on a mountain-top or as far away as the moon. Thus for more than two years, during his enforced stay in the leisure of his home because of the Plague, Newton wondered and experimented and calculated with such ideas until he finally came to this very important conclusion:

> Any two particles of matter in the universe attract each other with a force which is directly proportional to the product of their masses and inversely proportional to the square of the distance between them.

This, of course, is Newton's famous law of universal gravitation, a law that has done more to unify the great mass of natural phenomena, which was previously assumed but not proved, than any other one development.

At Barrow's request Newton, at the age of 26, replaced the famous Barrow as professor of mathematics at Trinity College, Cambridge. Acceptance of this professorship does not mean that he spent most of his time with mathematics. As a matter of fact, great mathematician though he was, Newton used to claim that to work on mathematics, very long at a time, not only tired him out but also greatly irritated him. This condition is probably one good reason why he was so interested in optics and other scientific fields where he could experiment and enjoy the privilege of working with his hands as well as with his mathematics. In all probability what Newton did with his hands, in an experimental manner, had as much to do with making his *Principia* a landmark as what he thought. Certainly the one ability could not have been separated from the other without loss.

Many great men of the past have projected theories and then tried to gather facts to support them. Even though Newton fell into this pattern occasionally, yet he always felt that the procedure was wrong-end-to. He was a staunch believer in first getting the facts and then proposing theories that such facts would support. By working from facts to theories Newton, over a period of 20 years, gathered such an array of remarkable results that he was finally persuaded by his good friend Halley in 1684 to put his findings in book form. This was a smart move on the part of Halley because no man other than Newton had ever possessed as many astronomical facts and the necessary mathematical background to present them. And Newton had such an

aversion to putting his accomplishments in writing that he probably would never have done so on his own initiative.

How any one man could write the three books which are included in the *Principia* in a period of eighteen months is beyond normal comprehension. Newton accomplished the feat, (1) because, for the preceding twenty years, he had been living, day and night, with the material which he was to write about; and (2) because he possessed an intense mental concentration that could blot out all distracting influences—even sleeping and eating, if necessary.

As one would expect of this kindhearted, humble, God-respecting man, Newton was careful to give honor to all the great men who had contributed to his success, by saying, "If I have seen further it is by standing on the shoulders of giants," yet the facts still hold that in all the history of mathematics Newton probably has no equal, and his *Principia* which is now rated one of the greatest contributions of dynamics and celestial mechanics ever produced, will probably always be listed among our great books.

FINLAND SENDS FAMOUS METEOROLOGIST TO WISCONSIN

An internationally-known meteorologist from Finland will be active in the research picture as a project coordinator at the University of Wisconsin during the coming year.

He is Matti Olavi Franssila, chief of the weather forecasting section of the Finnish department of meteorology. He also lectures regularly at the University of Helsinki.

Franssila came to the UW at the invitation of Prof. Verner Suomi, chairman of the department of meteorology, and will work closely with Suomi and Prof. Reid Bryson. He is a specialist on the heat budget and his special field is microclimatology. Franssila studied at the University of Helsinki, and received his master's degree in 1929 and his doctorate in 1936. He also studied for a time in Potsdam, Germany, in 1935.

He arrived on the campus Jan. 18, and will be at Wisconsin for about a year. His wife and four children plan on joining him next summer.

IMPROVED METHOD OF CASTING PERMANENT MAGNETS PATENTED

Better permanent magnets of the so-called Alnico type, which contain iron, aluminum, nickel and cobalt and have unusual strength, are promised with an improved casting process.

The process results in markedly improved magnetic directional properties, it is claimed. Such properties mean that the magnetic force is greater in one direction than in a direction at right angles. They have been obtained in the past by a heat treatment in a magnetic field.

In the new method the magnets are cast in molds or cavities in which heat loss through the sides during solidification is held to a minimum. The heat is removed from one end by means of a metal chill in direct contact with the molten alloy. This causes lengthwise extending crystals to form in the solidifying metal mass.

Inventor is Dolph G. P. Ebeling, Troy, N. Y. His award is patent 2,578,407. Rights have been assigned to General Electric Company, Schenectady, N. Y.

ISLE ROYALE, THE WILDERNESS PARADISE*

J. E. POTZGER
Butler University, Indianapolis, Indiana

From the blue, cold waters of Lake Superior rises a massive, warped and twisted mass of igneous rocks which man has given the beautiful and meaningful name ISLE ROYALE. And instinctively we say, "A mute evidence that the French were here." It is, indeed, a grand and royal island, whose massive rocky surface rises 705 feet above the turbulent blue waters of the largest and deepest of the Great Lakes. It is 45 miles long and nine miles across the widest point, making a total of 210 square miles. Its northeastern end has been cut, indented and worn down by the scour of slow-moving, but irresistible continental ice masses. The massive central portion has, however, defined the rasp of glacial ice and rises to-day majestically above the rolling waves of Lake Superior.

Isle Royale fascinates by its rugged, youthful topography. The rocks have barely been covered with a thin mantle of soil. A struggling forest of spruce, fir and Jack pine interspersed with the cheerful paper birch is paying for its pioneer position. The shallow-rooted trees are perpetually threatened with severe windfall.

Isle Royale is fifty miles north-west of the Keweenaw Peninsula (Copper Harbor) of Upper Michigan and 19 miles east of Grand Portage, Minnesota. Ridges of hard igneous rocks alternate with softer sandstone and conglomerate. The softer rocks have eroded into valleys which extend the length of the island, forming series of ridges and valleys. The principal and most centrally placed of these is Greenstone Ridge. Both small and large lakes are found in the valley troughs. Of these Lake Siskiwit is the largest (6 sq. mi.).

Isle Royale is surrounded by some 200 smaller islands which protect the fjord-like harbors, of which the 13-mile long Rock Harbor is the largest and the most frequented by lake steamers. Here is also located the center for tourist accommodation. This is made up of a comfortable lodge, Rock Harbor Lodge, and about 25 rustic cabins, supplied with stoves. Isle Royale is the only Island National Park in the United States. The true wilderness atmosphere is preserved in that no roads have been built, and even the trails lack conspicuous marking. In this wilderness characteristics it is like the famous Quetico-Superior Memorial Forest of Minnesota and Ontario.

The Island is noted for its semi-precious greenstone (chlorastrolite), which also gave the main ridge the name Greenstone Ridge. As early as 1844 copper mining was attempted on the island but because of

* This is contribution 251 of the botany laboratories of Butler University, Indianapolis, Indiana.

structural deformation of the rock strata mining was never a success. It was finally abandoned at the turn of the century. Previous to the coming of white man, the Indians here mined copper with crude stone tools, perhaps 600 to 800 years ago.

Isle Royale was never settled permanently by either Indians or civilized man, but summer cottages appeared on the rocky shores of the scenic island. In 1931 it was removed from private ownership when Congress set the area aside as National Park. Future generations will laud our generation for the wise move of setting aside tracts representative of the wonderful wilderness which was America's inheritance. This is our gift to the men, women and children of tomorrow where for all times to come a typical primeval condition will prevail where man may find a few weeks of peace and quiet from the noise and fumes of man-made canyons in metropolitan centers.

Vegetationally Isle Royale offers interesting distribution phenomena. It is a sort of "crossroads" where northern species mingle with typically southern species. Here is the northernmost limit of sugar maple which has established itself on the southwestern section of the island. From pollen records of the bogs on the island we know that hemlock and elm, too, had once been there but have disappeared again. Whether it was fire or some other cause which eliminated them no one knows. The forest as a whole is northern in aspect with dark spruce, fir and Jack pine as the most abundant representatives. A survey of some years ago listed 671 species of ferns and flowering plants. This includes 49 species of grasses and 106 species of rushes and sedges. Included also are 26 species of trees, eight of which are evergreens. Naturally, we find among these quite a number only sparsely represented. The northern character of the Isle Royale vegetation is indicated by the large number of shrubs, 87 in all. Three of the species are evergreens. One of the smallest of shrubs is the showy Canada Dogwood, or bunchberry, a midget of some three inches in height. This little shrub carpets extensive areas where shallow soil barely covers the massive rocks and boulders. In August the tiny plant displays great bunches of scarlet berries. Words cannot describe the beauty which demands attention from one and all who pass by. Stuck in the crannies and nooks of the rocks are rare wildflowers, in the soft carpets of the yellowish-green sphagnum mosses in the bogs are pitcher plant and sundew. Everywhere the visitor senses that he has entered Mother Nature's own sanctuary where man is merely a visitor and spectator. That is the atmosphere of true wilderness. On Isle Royale the "chasing through" masses who merely "do" a park are wanting. There is no place for them, this is the paradise of the nature lover, who is willing to hike to see the beauty of the wilderness without haste, without the encroachment

of civilization. Isle Royale invites the sympathetic biology teachers who are sensitively in tune with plant and animal life in their natural environment.

While the forest is not true forest primeval, it is a forest rebuilding according to the ancient laws of Nature, where planting and thinning is done by the plants themselves. Fire has played an important role on the island. Involved were fires started by lightning as well as by man. The two large fires during the past twenty years were both started by lightning.

The stately moose are without doubt the "royalty" of the animal inhabitants. I was impressed with the absence of hibernating species. No doubt they have for centuries missed the ice bridges while they indulged in winter dreams on the mainland. Very likely many or all of the animals represented on Isle Royale migrated over the ice in winter or could swim with ease. I was told that the moose crossed from Canada over the frozen Superior in 1912 under pressure of timber wolves. Moose are true children of the wilderness, shy, cautious, but also curious as human children. One day while boring a bog near Lake Ritchie we heard twigs break nearby. To our pleasant surprise we saw a yearling moose peep at us through the arbor vitae twigs, curiosity stamped on his every action. Such are the thrilling experiences on the great island in Lake Superior.

When the sun has crossed the equator at the autumnal equinox human activity on Isle Royale gradually moves into low ebb, and when the last flock of the majestic Canada geese has driven its great wedge into the wintery atmosphere the Park officials, too, migrate to the mainland and silence primeval takes over. Mother Nature tucks the rugged island under a blanket of white; the moose browse the twigs of fir and a wilderness as wild as prior to the coming of civilized man rules on beautiful Isle Royale.

LIBERAL ARTS AND ENGINEERING AT WITTENBERG AND CASE

Wittenberg College and Case Institute of Technology will offer a five-year combined liberal arts-engineering degree program according to a recent announcement from the two colleges. The plan will enable students to earn both the bachelor of arts degree and the engineering degree in the five-year period.

The program, designated as the "Binary Curriculum," involves three years study at Wittenberg and two years and a summer of work at Case. Upon completion of the graduation requirements of each institution, the student will receive the bachelor of arts degree from Wittenberg and the bachelor of science degree in a specialized engineering field from Case.

Wittenberg is the tenth liberal arts college with which Case has completed an agreement for a combined liberal arts-engineering curriculum. Other colleges included in Case's "Binary Curriculum" plan are Coe College, DePauw University, Dickinson College, Kenyon College, Marietta College, Miami University, Monmouth College, Oberlin College, and Ohio Wesleyan University.

MILTON O. PELLA, EDITOR FOR ELEMENTARY SCIENCE

With this issue we have a new representative for our department of Elementary Science. For some time we have had no representative on our editorial staff from Wisconsin. Now again the Badger state assumes the lead in this important mission.

Dr. Milton O. Pella, a World War II veteran who served for three years and seven months in Uncle Sam's great army, now continues serving the country in the important capacity of training teachers of science at the University of Wisconsin. Mr. Pella did his undergraduate work at Milwaukee State College and later received both the M.S. and Ph.D. degrees from the University of Wisconsin. His teaching experience includes work in the elementary schools, junior high, senior high, and now in college. In his present position as Assistant Professor of Education his principal responsibilities are the training of science teachers for the elementary, junior and senior high schools.

Since the 1949 annual meeting of the Central Association of Science and Mathematics Teachers he has served as a member of the Board of Directors. Now he assumes this additional work, replacing Miss Anna E. Burgess whose work as Directing Principal of the Cleveland Elementary Schools requires all her time. Dr. Pella is now at work on the journal and will welcome communications and contributions from all interested in this important field.

ARTIFICIAL HARBOR TESTS EFFECTS OF SUBSEA A-BOMB

Civil Defense experts will know how much time it will take to make our harbors safe after an under-water A-bomb explosion as a result of a "theoretical flume" in operation at Woods Hole Oceanographic Institution here.

The flume is an oblong glass channel. Fresh water comes in at a steady rate at one end and salt water, regulated to simulate the tides, comes in and goes out at the other end. When dye is added to the salt water, it can be seen moving up the stream as a sort of wedge.

With this model of a theoretical harbor, scientists can study how long it will take for radioactive water and debris to be flushed out to sea. The same knowledge can be applied to biological warfare agents used to contaminate one of our harbors.

More important right now are the peacetime applications. Sewage and industrial pollution emptied into our rivers are a problem in many harbors. A study of the interaction of the river and the salt water tides in this flume will give engineers knowledge of the safe rate at which waste can be introduced into the harbor.

The flume is housed in a separate building, one of the few anywhere with a waterfall coming out of one of its walls. The channel is 20 feet long. A moving weir produces the tides.

Harlow Farmer, hydraulic engineer of the Massachusetts Institute of Technology, is in charge of the flume which was constructed under a contract with the Office of Naval Research.

THE TEACHING OF COLLEGIATE MATHEMATICS

SCHOOL SCIENCE AND MATHEMATICS again presents one of its series on the teaching of collegiate mathematics. In general these have been phrased in the form of a letter which might be written by an experienced teacher, writing a young colleague just starting his career. This article is by Professor H. D. Larsen, Head of the Mathematics Department at Albion College, Albion, Michigan. Professor Larsen is well known both as a successful teacher and a textbook author.

CECIL B. READ
Mathematics Editor

Dear John:

It was indeed a pleasure to learn that you have cast your lot for the academic life and will begin your career at Blank College next fall. I know you will be richly repaid, perhaps not in material things but in a deep sense of satisfaction that will grow with the years.

You ask me for suggestions that might aid you in getting off to a good start. There are in the journals a few articles on the teaching of college mathematics which you will want to read. In particular, I recommend A. D. Campbell's *Advice to the graduate assistant* (A.M.M., Vol. 45, p. 32) and H. E. Buchanan's *A manual for young teachers of mathematics* (A.M.M., Vol. 53, p. 371). Also you will profit greatly by a careful study of *You and your students*, a very excellent manual containing suggestions for college teaching recently published by the Massachusetts Institute of Technology. Request a copy from the Office of Publications, Room 14-S132, M. I. T., Cambridge 39, Mass.

You will notice that these writers do not always agree. This merely confirms the fact that good teaching is a very personal matter and cannot be reduced to a formula. It is significant that we speak of the *art* of teaching. Teaching techniques that others have used successfully may not fit your personality at all. In fact, each class has its own individuality and classes will react differently to various methods. So, John, I advise you to experiment constantly to determine just what techniques best fit yourself and each particular class. But, you ask, how does one begin? The best advice that I can give you is to pattern your first methods after those of some master teacher. Think of the teachers you had yourself; at once you will recall some who were very good and some who were very bad. Try to analyze their teaching methods. What were the devices used so successfully by the excellent teachers? Where did the bad teachers fail? I am sure you will profit a great deal from this exercise, for it will suggest good methods to cultivate and bad methods to avoid.

The new teacher of mathematics usually has difficulty in getting down to the level of his students. Try to explain concepts slowly and distinctly, use words of few syllables, and be ready to give two or

three different explanations of difficult points. Remember that the average student is painfully slow to grasp new ideas, has forgotten most of the mathematics he learned in previous courses, and would rather do most anything else than think. Strive to be kindly, patient, understanding, humorous, and, above all, enthusiastic. Take the students into your confidence; explain the basis of your grading system and describe clearly what you expect of them.

A common failing of teachers of mathematics is that they talk too much. Give the students a chance to read and think for themselves. Encourage questions, but seek the answers from the students. Do not explain *all* of the next assignment—just enough that the student can finish reading the text with some understanding. Make each assignment rather explicitly by writing it on the blackboard at the beginning of the hour.

Now that you have completed your graduate studies, you will find time to become acquainted with a wealth of "enrichment material" which is available You will want to read such books as Ball's *Recreations in Mathematics*, Steinhaus' *Mathematical Snapshots*, Kasner and Newman's *Mathematics and the Imagination*, and Bakst's *Mathematics, Its Magic and Mastery*. These will suggest other books for further reading, all of which will provide a fund of ideas for making mathematics live and fascinating to your students.

Finally, John, as a teacher you will benefit from membership in such organizations as the Mathematical Association of America and the National Council of Teachers of Mathematics. Take an active interest in these organizations, attend as many meetings as possible, become acquainted with other mathematics teachers, and read the journals, past and present. There you will gain support and inspiration for coping with the problems of teaching mathematics which you will meet in the future.

I am certain that there are many other suggestions that I might well make, if I could only think of them now. But perhaps these few ideas will aid you in getting off to a good start. I shall be very happy to discuss any particular teaching problem which you may encounter.

With very best wishes, I am

Sincerely yours,

HAROLD D. LARSEN
Albion College

So far as agriculture is concerned, there is not the least doubt but that education in this country has been more responsible for our progress during the past 50 years than any other single thing. I am sure the same could be said for every branch of industry.—ALLAN B. KLINE, President, American Farm Bureau Federation.

SOME PROBLEMS OF VOCABULARY AND READING DIFFICULTY IN TEACHING JUNIOR HIGH SCHOOL SCIENCE*

GEORGE GREISEN MALLINSON
Western Michigan College of Education, Kalamazoo, Michigan

INTRODUCTION

It is common knowledge that today in the field of education the problem of reading is one that arises frequently. It is often stated that because of inferior methods of teaching reading many children are unable to recognize words when they see them, are unable to comprehend them when they do recognize them, but above all, cannot use them with fluency when they are expected to give oral and written reports. It is a matter of conjecture whether the condemnation of present methods of teaching reading is justified. But there is ample evidence to indicate that as the student advances through school his difficulties with reading are likely to become greater. One of the key points for such difficulties is at the junior high school level.

In general it seems to be assumed that the level for teaching reading is in the elementary school. As a result, few students receive a direct and concerted program of reading after this level. Hence, if a student is not competent in reading on leaving the elementary school, there seems to be considerable confusion as to what to do next. A survey of the records of the Psycho-Educational Clinic at Western Michigan College of Education indicates clearly that, with an enormous number of college students, difficulties with reading, and the subsequent academic failure, begin at the junior high school level.

In addition, the annual growth in vocabulary during the junior high school years is greater than during any previous level. The following data from Thorndike[1] substantiate this point:

TABLE I. ANNUAL INCREASES IN PUPILS' VOCABULARIES

Grade	Number of Words	Grade	Number of Words
1	800	5	1000
2	800	6	1100
3	900	7	1200
4	900	8	1300

Thus, it seems reasonable to state that at a place in the educative

* A paper delivered before the meeting of the Junior High School Group at the convention of the Central Association of Science and Mathematics Teachers at Cleveland, Ohio, November 24, 1951.

[1] Based on figures given by Thorndike, Edward L. in "The Vocabularies of School Pupils," *Contributions to Education* (J. Carleton Bell, ed.), Vol. 1, pp. 69–76. World Book Company, Yonkers-on-Hudson, 1924.

process where the annual growth in vocabulary is great there is little to indicate that definite programs of reading are undertaken to assist students with this growth. The problems that result are likely to be reflected in the academic achievements of the students in all areas of subject matter. In this paper however the discussion will be restricted to problems of reading difficulty in the field of science.

The Value of the Science Textbook and the Vocabulary Therein

Despite many tirades against the use of textbooks as learning materials, there seems to be little evidence that their use is declining. Nearly every student has a textbook in every course. There is of course doubt that all teachers use the textbook optimally. Yet, there is considerable opinion that, used judiciously, the textbook can make a major contribution toward achieving the objectives of science teaching. This viewpoint is supported in the Forty-Sixth Yearbook of the National Society for the Study of Education thus:[2]

> "In general, what seems likely to prove most satisfactory is to select a basic textbook that provides a good general outline of the course and the primary text materials which all the class may be expected to study and then to supplement this foundational material with a variety of materials from other textbooks, periodicals and reference works.
>
> The desirable procedure, therefore, is not to 'get rid of the textbook' (because any textbook is likely to provide better materials than the average teacher can improvise or assemble in the time and with the facilities available) but to avoid restricting the study to the contents of a single textbook and, instead, to supplement it as abundantly as may be necessary."

This viewpoint is substantiated by the research findings of Stafford.[3] In his study, he taught by means of the rotational technique a course in general biology to two equated groups of students. One of the methods of teaching involved the use of a textbook, and the other a collection of supplemental materials organized so as to cover the same material as found in the textbook. His findings failed to show that one method was consistently and significantly better than the other as far as academic achievement of the students was concerned. Thus, the time and effort required to assemble and organize the supplemental materials did not seem justified by the results that were obtained.

But, whether the textbook, or a combination of textbook and supplemental materials, is used, it is obvious that neither system will be of much use if the students are incapable of reading the materials.

---

[2] *Science Education in American Schools*, Forty-Sixth Yearbook of the National Society for the Study of Education, Part I. Chicago: Distributed by the University of Chicago Press, 1947. P. 48.

[3] Stafford, Wayne, "The Effect of the Use of a Textbook as Compared with Supplemental Material in Teaching Biology." Unpublished master's thesis, University of Michigan, 1951. Pp. v+69.

But, the task of writing textbooks so as to assure readability is not so simple.

There appeared in recent issues of *The American Biology Teacher* two articles that emphasized two divergent viewpoints. As a result of an analysis of biology textbooks, Malatesta[4] states:

"It (the biology textbook) consisted mainly of difficult scientific terms with equally difficult explanations. There was little to fire the imagination of the average student and lead him into what can be the wondrous field of nature."

The other viewpoint is expressed by Sister Payne[5] thus:

"Why should scientific terminology be simplified for him (the student)? Why substitute simple words or slang phrases for distinctive, scientific phraseology that is purposeful and pointed? Why step down educational levels? We need not assume that the present generation of students is endowed with less ability than the parental generation who passed similar courses. Do we not insult both parent and progeny by catering to mediocrity?"

The divergence of these viewpoints does not indicate lack of merit in either. Any textbook for science must be written so that the students for whom it is designed are able to read it. But to emasculate the scientific terminology to such an extent that accurate scientific meanings are not expressed would be equally unwise.

Therefore, it would seem desirable here to examine the research studies that deal with levels of reading difficulty of textbooks in science for junior high schools in order to determine whether or not they are too difficult.

Research Investigations of Vocabularies In Textbooks of Junior High School Science

A survey of the literature was made in order to locate studies in the area just mentioned. Two groups of studies were thus identified. The first of these consists of a summary by Curtis[6] of the results of one hundred investigations in the problems of vocabulary related to the teaching of science in the junior high and high schools. His summary indicates the following:

1. That both the technical and non-technical vocabularies of textbooks of general science . . . are too difficult for the pupils for whom the books are written.
2. That there is insufficient provision in such textbooks of science for difficult scientific terms and non-technical words.
3. That too large a percentage of the difficult words found in such textbooks of science are non-scientific or non-technical words.
4. That too small a percentage of the scientific terms that are introduced into such textbooks of science are defined.

---

[4] Malatesta, Anne, "Dry As Chalk Dust." *The American Biology Teacher*, XII (February, 1950), 27–8.

[5] M. Anthony Payne, O.S.B., "Some Queries, Mr. Editor." *The American Biology Teacher*, XII (May, 1950), 108–9.

[6] Curtis, Francis D., *Investigations of Vocabulary in Textbooks of Science for Secondary Schools*. Boston: Ginn and Co., 1938. P. 115–6.

5. That not infrequently the definitions of scientific terms fail to appear in the textbooks until the terms have been used more or less extensively in earlier parts of the book.

The second group of studies[7,8,9] appeared about twelve years later. All these studies measured level of reading difficulty by means of the Flesch formula[10] rather than by the word-count method used in the studies previously mentioned. Yet they substantiate in main the conclusions from the summary by Curtis. The conclusions were these:

1. That in general books designed for junior high school science are difficult for many of the students to read.
2. That although many of the textbooks are not difficult with respect to *average* level of difficulty, nearly all of them contain passages that would be difficult even for high-school graduates.
3. That the earlier parts of the books seem to be as difficult as the later parts. Hence there seems to be no provision for growth of reading ability during the year.
4. That the differences between the easiest and most difficult textbooks are statistically significant. Hence, the level of reading difficulty is a valid criterion for use in selecting a textbook.

Thus it would seem that the evidence indicates two points:

1. Textbooks for junior high school science are in general probably too difficult for some of the students to read with facility. Hence they are not likely to read them with a great deal of understanding.
2. There is no evidence if the studies of Curtis and Mallinson, et al., are any criteria that the levels of reading difficulty of textbooks for junior high school science have become more suitable over the last twelve years.

Two questions now become evident.

1. What can teachers do to select the most appropriate textbooks and when once selected to circumvent the reading problems that might arise?
2. What can authors and publishers do to improve their textbooks with respect to reading difficulty?

The Role of the Teacher in Selecting and Using Textbooks in Junior High School Science

It must be realized that the level of reading difficulty is only one criterion in the selection of a textbook for junior high school science. There are many other criteria, among them being style of writing, organization and clarity of material, quality of illustration, value of

[7] Mallinson, George Greisen, Sturm, Harold E. and Patton, Robert E., "The Reading Difficulty of Textbooks in Elementary Science." *Elementary School Journal*, L (April, 1950), 460–3.

[8] Mallinson, George Greisen, Sturm, Harold E., and Mallinson, Lois Marion, "The Reading Difficulty of Textbooks in General Science." *School Review*, LII (February, 1952) 94–8.

[9] Mallinson, George Greisen, Sturm, Harold E., and Mallinson, Lois Marion, "The Reading Difficulty of Textbooks in Junior High School Science." *School Review*, L (December 1950), 536–40.

[10] Flesch, Rudolf, *The Art of Plain Talk*. New York: Harper and Brothers, 1946. P. 197.

supplementary activities, and provision for individual differences.

First, the books available should be examined to determine which ones are likely to be appropriate. The examination may involve the use of a scale such as the one described by Vogel.[11] Such an examination may result in a tentative selection of four or five textbooks.

These in turn should be analyzed carefully for vocabulary load. In this analysis several factors should be borne in mind. The claims of authors and publishers with respect to vocabulary load should be considered carefully. One recent advertisement claimed, in essence, that the textbook contained "only three hundred fifty words of new technical vocabulary."* Such a statement is meaningless for several reasons:

1. A vocabulary of three hundred fifty technical terms in one science textbook may be entirely too great if the "normal" increase in all vocabulary for that grade level is twelve hundred.
2. Conversely, a vocabulary of three hundred fifty technical terms may be insufficient to explain adequately the scientific meanings that are to be developed.
3. The technical words selected may include many that are nonessential to an adequate understanding of science at that level. Further many essential terms may have been omitted.

A careful analysis then will demand the use of a word-count system such as that of Buckingham and Dolch[12] or the use of a formula such as that of Flesch.[13]

It should be remembered that *half* of all students in any course are below average. Hence, the textbook selected should have a level of reading difficulty from one to one and one-half years below the level at which it is to be used.

Once a book has been selected it should be examined carefully to determine whether or not the difficult terms have been defined and explained either in the text or in the footnotes when they are used for the *first* time.

If the teacher finds a number of words that are likely to cause difficulty for the students, it may be wise to list them. The students should then be given specific instruction in their pronunciations, spellings and meanings ***before*** the words actually appear in the text. Thus, it will not be necessary for the teacher to spend time correcting misconceptions that arise from the pupils' misunderstandings of such words.

In some textbooks that are otherwise of value, it may be desirable

---

[11] Vogel, Louis F., "A Spot-Check Evaluation Scale." *The Science Teacher*, XVIII (March, 1951), 70–2.

* The number of terms is arbitrary for obvious reasons.

[12] Buckingham, B. R., and Dolch, E. W., *A Combined Word List*. Boston: Ginn and Co., 1936. Pp. 185.

[13] Flesch, *op. cit.*

to eliminate sections that contain many words or sentences that are difficult to read.

The Role of the Author and Publisher in Preparing Textbooks for Junior High School Science

The following recommendations for author and publisher may well be of value for improving textbooks for junior high school science.

1. Before a textbook is actually written, it may be well for the author or publisher to search the literature to obtain lists of words or terms that are essential or desirable for inclusion in a course for junior high school science. If such lists are not available, the time required to prepare them may be well expended. These words, when they appear in the textual material should be explained clearly and, if above the vocabulary level of the students, should be pronounced and defined. Further they should be used in the textbook several times in different contexts so as to give the student additional opportunities to experience them.

2. Difficult non-technical words should be replaced with easier synonyms, unless absolutely impossible. In the writer's analysis of textbooks, it was found that many non-technical words could have been replaced with easier synonyms. If it becomes necessary to use a difficult non-technical word, it should be listed with phonetic spellings and with a clear statement of its meaning.

3. Authors and publishers should bear in mind that half the students in any class are below average. Hence it may be well to select a vocabulary that is from one to one and one-half grade levels below that of the grade in which the book is to be used.

4. For the better students it may be possible to include paragraphs or topics for individual study in which the levels of reading difficulty are commensurately higher. In this way it may be possible to provide somewhat for individual differences in reading ability.

5. Although there is frequent criticism that books are too large and hence more expensive than is desirable, it may be well to devote additional space for the inclusion of an adequate glossary. The glossary might contain the essential, desirable and difficult words together with their spellings. It may be well also to list such words at the ends of the chapters in which they appear. Thus, the teacher will be saved much time in preparing lists of words that may be stumbling blocks to or worthy of additional study by the students.

Life raft, an inflatable rubber affair in a torpedo-size aluminum alloy container, can be dropped from an airplane or launched from a vessel, expanding automatically when it hits the water. It is equipped with an engine and steering mechanism which can be controlled by radio from the mother ship.

SCHOOL FORESTS, OUTDOOR LABORATORIES FOR SCHOOLS*

CARL S. JOHNSON
The Ohio State University, Columbus, Ohio

In 1931 the students in the biology class together with some of the rest of the student body at Minford in Scioto County, Ohio, planted around 9,000 pine seedlings on nine acres of idle land which happened to belong to the school. The site was an outfarmed and then unproductive hillside, typical of around two million acres of Ohio land—more correctly nearly two million then and over one million now. The vital top soil, which never had been very thick on southern Ohio hillsides, was virtually gone. Each erosive rain—those summer rains of high intensity we may always expect—carried soil and subsoil from that hillside to join with the suspended soil in other moving waters rendering streams opaque to life-producing sunlight and being later deposited as unwanted silt in creeks, rivers, reservoirs and harbors or deposited at the mouth of the Mississippi River increasing the size of Louisiana's swampy delta.

The surface of the hillside had lost the major portion of its capacity to absorb water. The vegetative cover was sparse—briars and broom sedge mainly—and raindrops struck the earth surface all too often. The organic matter, once a part of the top soil, had been burned off, farmed out, and washed away and the soil, if it could be called that, was virtually without structure, that quality engendered by organic matter which makes a soil light, tillable, resistant to erosion, permits a balance between the air and water needed for plant roots, and makes it permeable to water. What little pore space remained through which water might have passed was sealed by the fine soil particles smashed loose by the impact of rain drops. Consequently most of the water from heavy rains ran off the surface of that hillside as from a roof and swelled streams to overflowing all too often. Furthermore, because so much precipitation ran off and because the soil's moisture holding capacity was so low there remained little water for plants. A site in a humid climatic area was capable of supporting only sub-humid vegetation.

This particular area, since it belonged to a school, contributed nothing to the tax duplicate but millions of similar acres in Ohio and in most other states yielded little or no taxes. These acres swelled area but, because they produced little or no wealth, not even wildlife, they were liabilities to the political subdivision in which they were

* Presented before the General Science Section of the Central Association of Science and Mathematics Teachers, Cleveland, Ohio November 23, 1951. Dr. Johnson is Assistant Professor of Conservation, Department of Zoology and Entomology.

located. Teachers' salaries certainly do not come from depleted resources.

Delinquent land is not restricted to any one state; it is all too common. Mismanagement of our basic natural resources—soil, water, and vegetation—which will, if continued, result in more land abandonment is still all too prevalent. These are losses we cannot afford and must not tolerate and all of you agree with those sages who say, "Something must be done about it." You will even go so far as to agree with that majority of our educational leaders who admit that schools should take some responsibility for the wiser use of our natural resources.

The biology teacher at Minford in 1931, however, did more than that. He made some conservation education very realistic by helping his students to actually practice wise land use (although it must be admitted that the reforestation of abandoned land is somewhat akin to locking the barn after the horse is stolen). However, this was a firsthand conservation experience for only a part of the student body of that one year, 1931. Thereafter, since no further planting and no management operations were carried out, it became only a visual experience. It has been a good visual demonstration for these twenty years for the site is on the school grounds and the hillside faces both the school building and the playground. But, to plant a forest and do nothing to improve it nor harvest anything from it for twenty years is not good forest management. Yet Minford had not touched this forest. Though the plantation has been needing thinning the Minford school has even purchased its Christmas trees. Unfortunately, this lack of management, this spurt of activity followed by years of mismanagement, is typical of Ohio's sixty-some school forests and not only of Ohio school forests but of most of the 1,300–1,400 known school forests in the United States. They have failed to follow up a realistic activity and have, thereby, become guilty of teaching the erroneous concept that reforestation is the principal activity in the wise management of forest-type lands.

Minford students did a good job of reforestation for more than 90% of the trees planted survived. In twenty years they have reached more than thirty feet in height. There is now a stand of upward of 800 trees per acre. A mature stand will have only 200 to 300 trees per acre at most. Competition and natural selection will be taking a harvest of at least 500 trees from every acre in say the next forty years. Not only is this a harvest which man should make but the process of selective thinning insures the survival of better quality trees, increases the growth rate of the trees which are left by relieving them of some competition, and aids man in protecting the forest from fire. Minford's students are now learning these and related principles in

the process of thinning one acre of that plantation. Tops and boughs from two-hundred trees are being sold to the city of Columbus for its Christmas decorations. The students will also be selling around 400 posts. Figure it out for yourselves as the students are doing with cash and you will see the lesson they are now learning: good forestry management pays. That is realistic conservation education; it really is "learning by doing."

School Forests are Practical Outdoor Laboratories

A few Ohio schools have farms, a few more have gardens, several have established wildlife areas, and 67 schools, including 18 colleges and universities, are known to have school forests. Only three states have larger numbers of school forests. However, they have much larger numbers than does Ohio: Michigan reported 627 and New York 265 in 1947. In the same year Wisconsin had 225 and now has around 250 having a very active and growing school-forest program. School forests in these states are also much larger, on the average, than are Ohio's but forestry is a more prevalent land use in those states than in Ohio. Ohio schools cannot hope to have the large acreages that these states have but we could have and should have many more such outdoor laboratories.

School farms or school gardens provide opportunity for a wide range of conservation work and would therefore seem more desirable than just school forests. However, farms and gardens require much attention during the summer months when our schools are not in session. A forest, though it provides a more limited variety of experiences than a complete farm unit, needs constant protection but only periodic attention. It is, therefore, within the realm of practicability for a great many schools.

What is a School Forest?

A school forest is any tract of land owned by or controlled by a school which tract is now forested or upon which a forestation plan is in operation. It may be any combination of native woodland, forest plantation, intended woodland area, and tree nursery. Lands planted to forests by schools but not controlled by them through ownership or by long-term lease cannot be called a school forest even though the reforestation may have been a good school project.

Project areas not owned or controlled by the school serve only as temporary laboratories and it has been noted that students participating only in tree planting may get an erroneous idea of what constitutes good forest-land management. They tend to believe that reforestation is the end or goal in the management of problem lands instead of seeing it as a remedial measure. Furthermore, without

long-term control, schools cannot well demonstrate further steps in management, cannot benefit from multiple uses of such lands, and will not be able to clearly demonstrate—as Minford is now doing—that conservation pays.

Good School Forests Serve Many Purposes

Forests in general have four uses: (1) production of forest products, (2) watershed protection, (3) recreational opportunities, and (4) habitat for wildlife. The possibilities for the realization of these values is increased with sound management. Such management should be a part of the school-forest program. In the good school forest, nature-study areas, nature gardens, arboretums, recreation areas, nature trails, wildlife habitats, and the like may be included in natural settings. In such laboratories, children, through actual participation in directed activities or firsthand learning experiences, can acquire a wide variety of conservation knowledge. They can learn tree planting, seed gathering, seedling production, identification of species, the economic values of some species, marketing, grading, selective cutting, timber harvesting, forest inventory, wildlife identification, wildlife management, ecology, plant pathology, and other specific knowledges related to land management. Of even greater importance to the general student are the positive attitudes for the protection of forest land from fire and grazing which are acquired through demonstration and because of the feeling of ownership and responsibility. Actual work with vital biological problems can be fruitful of desirable attitudes with respect to the wiser use of our natural resources.

Schools Can Have School Forests

The objection to outdoor laboratories most often raised is, "Yes, but we can't. We have no land." In general, that is not true as often as the initiate in school-forest work believes. A great many schools already have land which might be used for an outdoor laboratory and an even greater number could obtain such lands if they so desired.

A survey of Ohio schools in 1947 showed that 869 rural high schools owned a total of about 2,700 acres of land that they were not then using, an average of 3.1 acres per school. One-hundred and forty-five city high schools owned 320 acres of idle land, an average of 2.2 acres per school. Eighty-eight exempted village schools owned 264 acres, an average of 3.0 acres, and 140 private and parochial schools owned 4,370 acres, 30.9 acres per school. These areas of idle land *owned by schools* total more than 7,500 acres. In addition the rural schools reported that at least 6,000 acres of waste or abandoned lands adjoined their grounds.

Admittedly city schools have least and it is not conceivable that

much school-forest land can be found within corporation limits. However, it has been demonstrated in several cities and villages in Ohio and elsewhere that there are ways in which city schools can obtain the use of some land for school forest purposes. Witness school forests on water-reservoir or water-well lands at New London and Rushville in Ohio, school-forest, areas planed in the Columbus Metropolitan Park System, Seattle's 1,000-plus-acre school forest, and the school camp sites in Michigan and California. We also know of three places in Ohio at the present time where individuals have forest lands they would like to give to a school if these schools would but show genuine interest.

What Should be the Characteristics of a Good School-Forest Program?

Based upon a study of school forests in other states, the Ohio Forestry Association adopted a set of standards by which the merit of school-forest programs might be judged. Some of the specific criteria cannot be applied in all other states, or even in all instances in Ohio, but the intent of each statement is widely applicable.

1. The school forest should be ten or more acres in size to be an economically manageable unit on which a block plan may provide experiences for students year after year. When circumstances prevent the acquisition of an area of this or larger size, intensive management should be planned such as nursery or Christmas tree production.
2. The tract should be owned by the school or controlled by renewable long-term lease. Agreements made under any cooperative plan should be formalized for a school forest is a long time project outlasting the men who might enter into agreements.
3. A written, specific, and long-term management plan with quite definite annual tasks or objectives should be prepared and should be revised in writing as needed.
4. The school-forest program should be directed by a committee or a board so constituted that sound planning and continuity is assured. The type of teacher that initiates such programs is too apt to move on to higher positions.
5. Multiple use should be planned for the area. Education should be the main use but recreation, wildlife, and the production of forest products for use or sale by the school should be considered. Day camping and school camps are desirable related uses also.
6. General participation by students in planning, developing, and managing the area to the extent of students' abilities and the educational values to be gained should be evident.
7. Annual and complete records should be kept of income and expenditures, of work progress, of participants, and of changes in plans. The records should include maps and photographic records.
8. The area *must be protected* from fire and from grazing (except that it should be recognized that regulated grazing is an acceptable use of some western forest lands).

You Can Get Help in Developing a School-Forest Program

If your school does not already have some land that could be used for learning better land management, the school board might be will-

ing to acquire some if teachers and a number of people in the community were interested or, as previously indicated, such lands may be given to schools by municipalities, by industries, or by individuals.

Your Agricultural Extension Agent, the Farm Planner in your Soil Conservation District, or some forester near you can often help your school with development and management plans. Four Ohio schools have obtained help in planning by cooperation with their local Soil Conservation District. Often some citizen in a community who is already practicing good forestry will be glad to help your school.

If you are in need of planting stock, see your Agricultural Extension Agent. In most states he handles requests for stock from state tree nurseries. In many states planting stock is furnished free to schools. In Ohio a school may receive gratis 1,000 seedlings a year for planting on school-owned lands. In several instances local organizations have purchased additional planting stock for schools.

There are a great many useful publications on the management of small forests or woodlots. Write to your State Forestry Division. Consult your Extension Agent. Perhaps your state, like Ohio, has a Forestry Association which will produce publications like our *Forests for Ohio's Schools*, or a Conservation Department which like Wisconsin's will produce another *School Forests, A Handbook*. But do give your students an opportunity to show you how much information they can dig up for the purpose of planning and managing *their* school forest.

Your state will have a number of wood-using industries. Ohio has over 2,000. There may even be one in your community. If your school were to show some interest in the forestry phase of the vital conservation problem, they might be of help to you in many ways.

If you are unable to get help locally write your state Forestry Association, your State Forestry Division, State Department of Conservation, or the U. S. Forest Service. If all this does not work, write to the author of this paper. Do not be stopped by either your own or someone elses "I don't know."

If you happen to teach in some state having an active program for promoting and helping with school forests special helps are available. In Wisconsin contact Wakelin McNeal, Extension Division, University of Wisconsin. Fully half his time is committed to helping with school forests. Through him you can obtain a number of special aids such as help with mapping, the aforementioned *Handbook*, information on obtaining land, and technical advice. In Michigan, though there does not seem to be any special personnel or program for the specific purpose of helping with school forests, helps are available locally or through the Department of Conservation. Under the provisions of the Michigan law regarding state and tax-delinquent lands,

schools have and still can obtain lands for forests and school camps very easily.

In Ohio the Ohio Forestry Association—a membership organization not to be confused with state forestry divisions—sponsors a special program for giving aid to school-forest programs and for giving recognition to creditable programs. This recognition is in the tangible form of a fairly large and durable school-forest sign which is presented to a school whose forest program meets the standards just referred to. More important is the aid that the Association furnishes indirectly through advising a school whom to contact locally for technical advice or directly through the persons of the Association's forester, Robert O. Paton. Some help may also be obtained from the Association's school forests committee of which the author is chairman. (Address of the Ohio Forestry Ass'n. is Southern Hotel, Columbus, Ohio.) Under this program for the recognition of achievement, twelve Ohio Schools have received the school-forest sign.

So why don't you help start the development of a learning facility which will outlast both you and the building in which you work. Develop a learning facility which puts books in their more proper place, makes them sources of information for solving real-life problems. Develop a school forest in which generations of children will learn at first hand some of the things which are important parts of urgently needed education for the wiser use of our vital natural resources.

SUMMER SESSIONS AT COLORADO STATE COLLEGE
GREELEY, COLORADO

Pre-Session, June 9–19 (two weeks, maximum of 3 quarter hours credit)
Summer Session, June 21–August 15 (eight weeks, maximum of 12 quarter hours credit)

TUITION AND FEES

Quarter Hours Credit	*Tuition Colorado Residents*	*Tuition Non-Residents*
1–3	$16.50	$16.50
4	22.00	22.00
5–8	35.00	40.00
9–12	40.00	45.00

Summer Session fees for all programs of five or more quarter hours credit are: Registration, $3.50; College Service, $6.00. Late registration fee is $5.00. Fees for special services and individual instruction (e.g. music) are charged in accordance with the schedules in the catalog. The laboratory fee for Camp Leadership (Summer Camp) is $10.00.

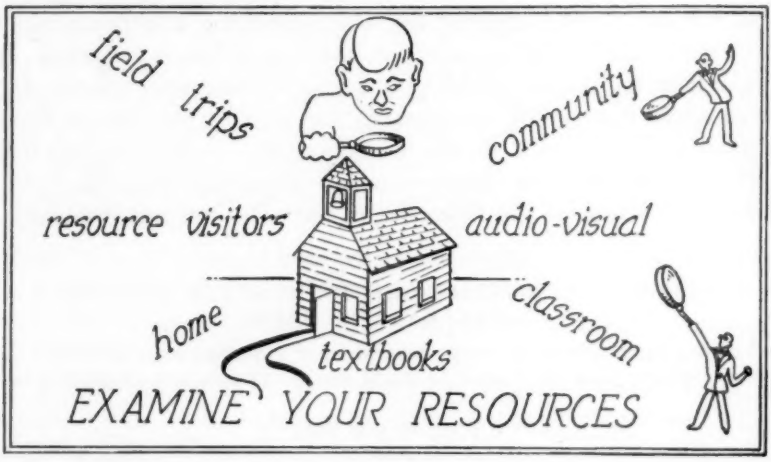
Magnifier equipped with a pair of spring clamps can be snapped onto any standard thermometer and can be moved up and down to magnify a full two-inch section. It enlarges the thermometer section enough so that readings can be taken from a six-foot distance.

YOUR SCIENCE RESOURCES ARE SHOWING

RAYMOND G. KENYON*
State Teachers College, Fredonia, New York

Yes, your science resources are showing in the classroom, outside the school, around the community, and even in the child's own home. The value of any on-going elementary school science program depends upon the effective use of these resources, when and where you find them.

If you are studying electricity, remember that what the child sees is bringing a greater measure of meaning and understanding to him. In the home and in the classroom there is electricity that children can observe. Their attention can be directed to light sockets, bulbs, switches, wall outlets, record players, insulated wires, the classroom thermostats, radios and electric clocks.



When the pupils are wondering about air and weather, direct observations toward the thermometer and barometer which may be in the room. Try opening the windows in the room when clarifying concepts of air currents. Further exploration of air currents and heat travel in the classroom may necessitate a trip to the basement of the school where the furnace is located. The school custodian can be of great assistance in helping to trace the hot air through the pipes into the classroom.

Certain simple chemical changes are also easily observable. Notice the discoloration of any multiple-glass plate window in the school. It has turned yellow because the balsam liquid that was used as an adhesive has aged. Rusting may be noticed on the radiators in the

* Science Consultant for the State Education Department, New York State.

room, on the door hinges and on the pipes in the basement of the building. Children can also learn about chemical change by looking at the fire extinguisher in the hall and, through operating it, see for themselves this change.

The schoolyard affords many opportunities to observe conservation or the lack of it. After the rain has fallen, take a walk through the schoolyard so that pupils may notice how water has formed gully erosion and is carrying away soil. Suggest that some of them collect this water in a glass jar and, after allowing the water to settle for a period of time, observe that soil that was being carried away by the water has settled in the bottom of the jar. Have them notice too, how a path has been worn across the school lawn, leaving no grass to protect the wearing away of soil. Inside the building, point out that the floors and other woodwork have been varnished or painted to protect the wood from deterioration.

Try another trip to the playground. There are flowers in bloom or lying dormant until spring and summer; there are many kinds of trees which do or do not change foliage during the period of a year; there are seeds from trees, pollen from flowers; there are ants busy carrying food; there are birds with different plumage and varying calls; and don't forget the fog, dew, hail, snow, rain, and rays of the sun.

The child's home provides a natural setting for his witnessing science and its functions. He can see his father's jacks, screw drivers, saws, chisels, and other simple and complex machines. On the farm, he will notice the water pump, farm machinery, gates, and countless other things that relate to science. The girls will have firsthand experiences with the electric toasters, knives, corkscrews, diversified cooking utensils, electric vacuum cleaners, different textiles, and the planning of menus. Such experiences and observations make the child a primary resource in clarifying science in the classroom.

Within the community are available various people, places, and things which can be used as resources. There is the photographer who can explain lenses, reflection of light, photographic chemicals, and picture taking; the astronomer who can give meaning to the telescope and its uses; and the local weather observer who may aid in helping to motivate a trip and can crystallize what the children should look for when they later take their trip to the weather station. In every community there are to be found other resource persons such as a doctor, who will speak about the latest medicines and health; the garden club member, who can explain planting, growth, and soil composition; a worker at the airport, who will contribute the so-indispensable information on aviation and weather; a farmer, who can talk about the conservation practices in the vicinity; and the owner

of the hardware store, who may be a specialist in the field of simple and complex machines, a heating expert, or home lighting engineer. Such people may be considered a primary source of information.

Such places as the telephone exchange, the parks, the radio station, reservoirs, water purification plants, weather stations, an airport, county experimental station, game refuges, local industries, and a multitude of other places are essential to visit if the resource personnel cannot come to the school. It should be said that the success of using community resources depends upon teacher-pupil planning and subsequent arrangements. The teacher and pupils alike must know where they are going, what they are going to see, what they want to know, and what they need to re-examine when they return.

Your science resources are showing. They need to be used much more than they have been in the past. There is no doubt that reading is essential to any science program; but allowing the children to explore for themselves is going to make that reading more meaningful.

A SYMBOL TEST IN MATHEMATICS

JOHN SPADE
Springdale High School, Springdale, Pa.

Word	*Symbol*	*Word*	*Symbol*
greater		angles	
parallel		perpendicular	
less		angle	
degree		minute	
not equal		not parallel	
not perpendicular		congruent	
triangle		square	
rhombus		parallelogram	
rectangle		quadrilateral	
add		multiply	
subtract		divide	
plus or minus		ratio	
therefore		parentheses	
brackets		braces	
bar		arc AC	
cord AC		sq. root 16	
imaginary		C sub one	
pi		r prime	
fraction		proportion	
polygon		circle	
similar			

Our universities and technological institutions must be made financially secure as vital and dynamic instrumentalities for progress. And free at all times to establish the truth. Far too many are presently in need. The alternative is government support. That means, in the final analysis, political domination. There is no escape.—ALFRED P. SLOAN, JR., Chairman of the Board, General Motors Corporation.

A SCIENTIFIC APPROACH TO CURRICULUM CONSTRUCTION

NATHAN S. WASHTON
Queens College, Flushing, New York

What shall we teach in science and in mathematics? Are we teaching subjects, courses, or people? Do we teach essential things in life that intelligent citizens need in order to live effectively in our modern society? How do we determine what should be taught? Perhaps a scientific approach to the construction of a curriculum may be an effective method in determining the content to be taught in science and mathematics. The approach is not new. Many schools have called upon committees that include teachers, consultants, citizens, pupils and administrators who have worked cooperatively in order that a good program of instruction may be developed. However, most schools have not explored fully the various resources available that make for a more effective program in science and mathematics.

Every teacher believes he knows what he should teach. This is basically true for all teachers regardless of level of instruction, i.e., elementary, secondary, or college and university. Not all of the teachers, however, have examined with any degree of accuracy or completeness as to why or how they teach the selected subject matter to their pupils. The result is that the selection and organization of content and materials and methods of teaching have been transmitted from generation to generation.

Many teachers have imitated the kind of teaching they experienced as students. A beginning teacher very frequently teaches a course in the same way he was taught the course when he was a student. He was impressed by that teacher. At that time the course may have been taught most effectively. However, several investigations and studies pertaining to the teaching of science and mathematics have appeared in print from the time the beginning teacher was a student in the course he now teaches. Few changes were made to improve this course. Some of this "hereditary" type of teaching was good, but some of this "genetic" teaching was poor. Can we remain oblivious to the findings produced through educational research? It seems that discoveries in the science of education would cause teachers to modify their practices in terms of this new evidence. Certainly it is expected that medical practitioners apply the most recent and effective techniques that would benefit human health and welfare. Until such time as the equivalent is achieved in the teaching profession, what and how we teach will be influenced chiefly by academic heredity rather than by recent advances in education.

To enable teachers to utilize and benefit from recent advances in science and mathematics education in order that pupils may derive the best instruction available, it is proposed that (1) every public school acquire a professional library for teachers. This library should contain professional journals such as SCHOOL SCIENCE AND MATHEMATICS, *Science Education*, *The Mathematics Teacher*, the several yearbooks, *Science*, *Scientific Monthly*, *Scripta Mathematica*, and many other periodicals and books. (2) A faculty committee in each school should assume responsibility for disseminating information about current investigations in science and mathematics education. (3) Schools should encourage and finance in service teacher training courses for all teachers who wish to be well informed in their areas of specialization. (4) Representatives of each school should meet with parents and other citizens in the community to discuss how better methods and materials of instruction are being introduced in terms of these new discoveries.

The textbook is still a common determinant of what we shall teach. It is unfortunate that many of the teachers depend completely upon the textbook as a means of organizing and selecting the content of a course in science or mathematics. If a certain topic, for example, such as the nutrition of plants and animals, is given more space or words in a group of textbooks, many teachers believe this topic is important and therefore a greater amount of time is needed to "cover" this area or topic. This assumption would appear reasonable if textbooks were written in terms of criteria of general education or other justifiable standards and would satisfy the needs of students and the objectives.

If one were to examine a number of textbooks in a given subject for the past fifty or seventy-five years, it would become obvious that there is also a "hereditary" factor that influences the retention of much material in the new books that was handed down from the old books. New authors even include the mistakes of their predecessors. It does not follow that new texts are undesirable if they contain much of the material that appeared in the textbooks fifty or more years ago. Many mathematical concepts as described in recent textbooks did not change in basic theory from the mathematics textbooks of several hundreds of years ago.

"On the whole, the content of arithmetic textbooks during the 150 years included in this study has not changed a great deal. Throughout that period of time there has been certain core content that has been included in all or almost all the texts studied, with much of this core material having been handed down through the ages as vital to the study of arithmetic."[1]

[1] Smith, Henry Lester, "One Hundred Fifty Years of Arithmetic Textbooks," Bureau of Cooperative Research and Field Study, Indiana University, Bloomington, Indiana, pp. 145–6.

With the exception of a few of the more complicated topics that were transferred to higher mathematics, very few topics were omitted from the texts. However, new material was included in arithmetic textbooks in recent years to make them more meaningful in attempting to meet the needs of pupils and society. Basic mathematical operations and skills still remain the same. The approach to teaching mathematics has changed. The emphasis in teaching mathematics is to apply the knowledge and skills of mathematics to every day problems of living. The individual student's abilities, aptitudes and skills receive greater attention today as compared with two or three decades ago.

Nevertheless, the teaching of the *application and use* of mathematics in human affairs can be greatly improved. This becomes more evident when one examines the textbooks used in the secondary schools. The science textbooks present other problems. The basic principles of the natural sciences have increased in number and were modified to some degree as a result of scientific research. Textbooks in the natural sciences have increased from less than two hundred pages to more than six or seven hundred pages within the past fifty years. The number of hours devoted to the teaching of the natural science courses remain practically the same within this period. Yet, students are expected to "master" or learn the old principles as well as the new information with no additional time allotted to study or teaching. Hence, if the textbooks represent the sole basis for selecting content as is the case in many schools, it becomes increasingly difficult to develop the objectives of education.

In chemistry textbooks one reads about the original Arrhenius theory of ionization, the phlogiston theory, Dalton's theory and many other theories that were modified in recent years due to further investigations in science and technology. Yet, many teachers believe that students should memorize the fallacious assumptions given in the original theories in addition to the recent changes accompanying these theories. Why? Some teachers insist upon this requirement because this information is in the textbook. Others believe it's interesting. To whom? To the chemists? To the general student? Many teachers believe this information has cultural value or is useful in developing scientific thinking. How? Can the selection of this content be justified in terms of accepted purposes of education?

In biology textbooks, the theory of protective coloration appears quite frequently. The fact that Lutz, former curator of entomology of the American Museum of Natural History, discovered that some insects cannot distinguish color, has not modified the teaching of protective coloration pertaining to butterflies, and other animals. Many

teachers believe it is good story telling. Hence it is found in many high school texts.

Textbooks seldom show the social implications of biology or science. If one is to understand psychology and sociology, a knowledge of biology is needed. And few teachers have pooled the resources of their colleagues. To what degree does the biologist understand the contribution that his colleagues in social studies, economics, health, psychology, sociology, and mathematics make towards developing the purposes of education? Can secondary school teachers representing various fields of knowledge work independently of one another and still teach effectively with a view towards developing the purposes of education?

Many teachers "cover" their topic in a classroom period by lecturing or questioning students on an assigned number of pages in a given textbook. They have accepted what appears in the assigned readings as the material to teach. Not many teachers have given any serious thought about the purposes of teaching these topics, generalizations, problems or facts that appear in print. It should not be assumed that there is no place for textbooks in the program of instruction. Textbooks may be used to complement, supplement or strengthen instruction. They should not be used as the sole basis for giving instruction. A scientific study of the purposes of education in America should influence the selection of content and materials to be taught. If every teacher would re-examine the purposes of education and the contribution that each area of knowledge and experience makes to these purposes, a desirable change in content might occur. A number of schools have utilized this approach with highly satisfactory results.

In many schools throughout the United States what we shall teach is strongly influenced by a syllabus which may be prepared by an individual, a local board of education, a state department of education, pressure groups, or some professional agency. Unfortunately, in a number of school systems, teachers believe they must teach the syllabus as though it represented a contract. Some of the syllabi are excellent and may serve as effective guides to teaching. However, the question arises again what is the basis for preparing a syllabus that will meet the needs of individual students, the community, and the nation.

One of the first tasks is to determine what are the purposes of education in America. In a recent study[2] which utilized previous reports, investigations, and a questionnaire, the writer stated the following purposes of general education:

---

[2] Washton, Nathan S. "A Syllabus in Biology for General Education," *Science Education* 35: 84–92; March 1951.

To provide students with the necessary knowledge, skills, and attitudes in order that they may:

A. Understand the world of nature, physical and biological, and be able to interpret natural phenomena.
B. Have some appreciation of the background of the civilization which is our heritage.
C. Understand the social, economic and spiritual forces at work in society and develop a sense of social responsibility.
D. Gain a better understanding of the meaning and purpose of life and a truer sense of values.
E. Participate more effectively in solving problems of contemporary society.
F. Maintain and improve their health and share in the responsibility for protecting the health of the community.
G. Attain an emotionally stable personality and make a worthy social adjustment.
H. Utilize a scientific approach in solving problems dealing with society and human welfare.
I. Be better fit for family and marital relationships.
J. Communicate effectively through oral and written expression.
K. Develop a code of behavior which is based on ethical principles consistent with democratic ideals.
L. Recognize the interdependence of the different peoples of the world.
M. Recognize and accept one's personal responsibility for fostering international understanding and peace.
N. Appreciate the best in literature, art, and music, including drama, the dance, radio and motion pictures.
O. Discover their own abilities, aptitudes, and interests and choose a vocation.
P. To understand the place of the consumer in society and to learn to become an intelligent consumer of goods, services and time.

The next step could be the listing of specific objectives for each course. In teaching science and mathematics, one could list specific skills, principles, concepts, and attitudes that may be developed. The listing of these specific objectives should not be accomplished solely on the basis of one teacher's experiences or beliefs. A competent committee of teachers and other qualified experts should carefully evaluate the needs of students in a given secondary school and the needs of the community before attempting to formulate specific objectives for each science, mathematics or other course. A careful study should be made of how each area of knowledge contributes towards the development of both the general and specific objectives of education.

To assist classroom teachers in formulating specific objectives in teaching science, the following criteria[3] are suggested:

1. Are the statements (objectives) *practicable?* Could the classroom teacher use them in developing these objectives that are ultimately desired?
2. Are the objectives based upon *sound psychological principles?*
3. Is it possible to measure the *progress towards achieving* these objectives under suitable conditions in a ordinary classroom?
4. Are these objectives *universal* in our American way of life? Do they apply to all creeds and racial groups?

The selection of content should be carefully examined and evaluated in terms of how such content can contribute towards the development of both the purposes of general education and the specific objectives of science and mathematics courses. In making this selection of what we shall teach, we should analyze the content in textbooks, consult experts in subject matter and in education, study the materials in periodicals and newspapers and consider the interests and needs of students as suggested by the objectives. A periodic review and evaluation of this content should be made to bring it up to date and make it more meaningful.

The effective use of materials and methods of teaching will affect the degree in which progress is being made in the development of these objectives. Scientific thinking should be taught wherever possible if it is to be developed as an objective. Likewise, one must teach for transfer of training directly if any of the objectives require the application of knowledge or skills in new situations or experiences. If a student is to learn how to apply a mathematical theorem or a scientific principle in solving a different type problem, the teacher should teach how such transfer can be developed.

[3] National Society for the Study of Education, *Science Education in American Schools*, Chapter III. The Forty-sixth Yearbook of the National Society for the Study of Education, Part I. The University of Chicago Press, 1947.

INDIANA UNIVERSITY WORKSHOP

Indiana University will holds its Fifth Annual Workshop for Teachers of Mathematics on the campus at Bloomington, Indiana, June 23 through July 5. Opportunities will be provided for teachers to work on their specific problems. There will be lectures from representatives of industry, as well as a mathematics laboratory in which the workshop membership may work on projects to their liking. There will be on display recent text materials, textbooks, audio-visual aids, and other items of interest to mathematics teachers. For those who wish it, university credit will be allowed. A program will be available by the first part of May. If interested write to Philip Peak, Workshop Director, Education Building, Indiana University.

HOW TO USE PROJECTS IN TEACHING HIGH SCHOOL CHEMISTRY*

LOUIS PANUSH
Central High School, Detroit, Michigan

Anything that teachers do which results in pupils' learning is a method of teaching. Although many people believe that the personality of the teacher is the greatest single factor in producing successful results in teaching, nevertheless many of the most important achievements in any given course of study is the product of the method or, rather, the combination of methods employed by the teacher in the classroom. Lecturing, quizzing, class discussions, "old-fashioned" assignment of homework and study materials or supervised study, class demonstrations or individual laboratory experimentation, inducing students to do study exercises and carry out end-of-chapter activities, stimulating them to work projects—term papers, construction, models, mock-ups, special experiments, etc., dramatizing, and a great variety of many other techniques employed by teachers, all are methods of teaching; all form an integral part of the general scheme of teaching.

There is considerable difference of opinion among educational research workers and science teachers as to which is the best method of instruction. No method can be stated as being superior to others unless it is supported by conclusive data obtained from scientifically controlled experiments. The results of investigations of teaching techniques are somewhat limited and not conclusive. The teacher may very well take to heart the suggestion made by the Thirty-first Yearbook in regard to teaching techniques: "The teacher should welcome every new method, device or plan, or each improvement of an older technique as a potential means of increasing classroom efficiency. He should master many and varied teaching techniques to the end that he may more efficiently adapt his methods and the instructional materials to the individual differences of the pupils in his charge."[1]

The use of term projects in the teaching of science, and particularly in the teaching of high school chemistry, is based upon the premise that effort follows interest, that the pupil will try to learn that in which he has a real interest, and that which he will learn will depend largely upon the amount and kind of effort which he will put into trying to learn. The essential factor which makes projects a worthwhile and successful educational activity is the fact that the

* Based upon a talk given at the Second Annual Conference on the Teaching of Chemistry, held at Michigan State College, August 28–31, 1951.

[1] Thirty-first Yearbook, 1932, Part I—*A Program for Teaching Science*, National Society for the Study of Education, Chicago, p. 89.

pupil is provided with an opportunity to select and work on a subject, activity, or problem in which he is interested and which he will want to bring to a successful and satisfying conclusion. The project is a device which allows for individual differences in intelligence, ability, initiative, imagination, curiosity, interest, and achievement on the part of the individual student. In a sense, it is a method of research which will help in developing growth in the habit of thinking, in functional understanding of facts and principles, in appreciation of the contribution and importance of chemistry—adapted to the age and the capacity of the student. It is a potential means of enriching the course, of providing a worthwhile leisure-time activity for the student, of utilizing principles and fundamentals learned in class work, and of giving the student an opportunity to make a real contribution to his own knowledge and to the class.

I have made use of projects in my chemistry classes on and off since 1936. The second half of the high school chemistry course, which is devoted primarily to applied chemistry—in industry, medicine, the home and the community, and in many areas of modern living—lends itself extremely well to successful utilization of the project idea. In the late thirties and in the first two years of the forties, I have had considerable success with term projects. Many students went in for models, apparatus, and displays, and a great many of these were excellent. In an exhibit sponsored by the Detroit chapter of the American Chemical Society in cooperation with the Metropolitan Detroit Science Club, they won first prize in 1939 and second prize in 1940. The idea was given up during the war years, since students' minds were pre-occupied with imminent draft, service, and war, and it was out of the question to require of them to do anything more besides their homework. During the last two years the idea was revived and projects are again required, especially in chemistry (2), since the basic fundamentals, laws and principles are studied in the first half of the course.

Projects, or term papers, are required of *all* A and B students as a supplementary activity to class and laboratory work. The other students may work on a project, or do research for a term paper, if they wish to (1) raise their grade, (2) keep their grade in case of "weakening" or slipping, and (3) increase their knowledge in an area in which they have a special interest; a worthwhile contribution is rewarded with an improved grade and with proper recognition by the instructor and fellow students.

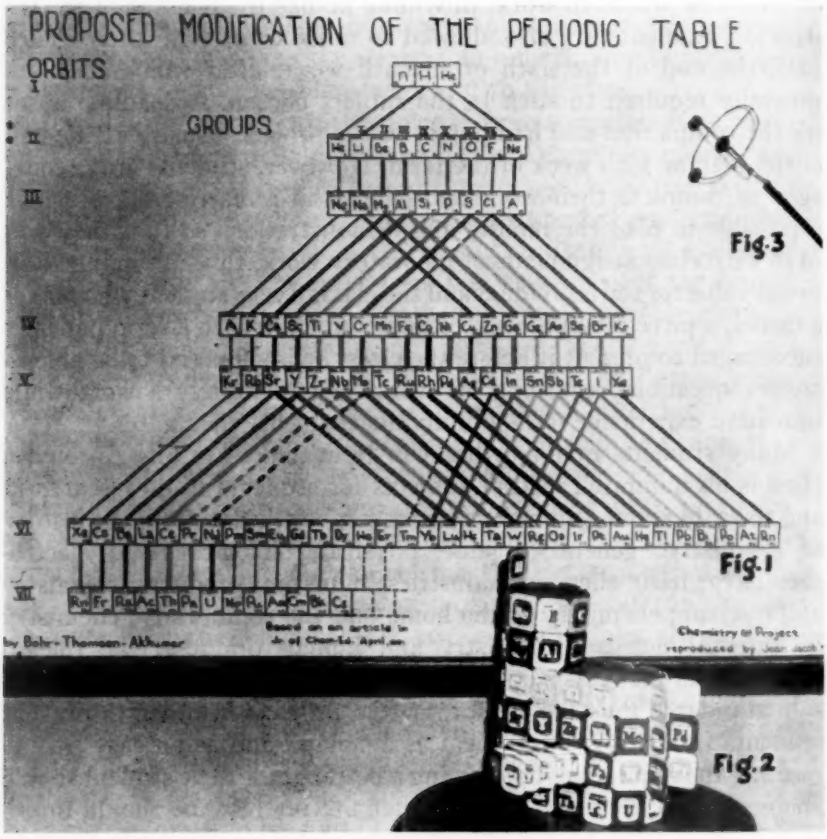
The procedure used in assigning, selecting, and integrating the term projects is usually as follows: At the beginning of the semester, after a general introduction to the semester's work, the methods to

be employed by the teacher in class and laboratory, the system of grading, etc., the students are told of the project or term paper which is required of them by a definite deadline. A rather comprehensive list of subjects for term reports, models, apparatus, displays, demonstrations, etc., prepared from many sources and continuously revised, is posted on the bulletin board. After consulting the list (and the instructor, if so desired), students must hand in a card with a tentative choice of what they want to do by the end of the third or fourth week. It is not obligatory to choose a subject from the list; one may submit his own project or topic in which he is interested and on which he wants to work, providing he has the consent of the instructor. Students are also allowed to make changes in their choice until the end of the sixth or seventh week, after which they are generally required to stick to the subject chosen. A deadline is set for the completion and handing in of the project, usually at the end of the 14th or 15th week of the term. However, students are encouraged to complete their work and hand it in as early as possible. It is possible to plan the reports and demonstrations so that they will fit in with class assignments or laboratory work, thus obtaining additional value for the individual and the class. Every student who makes a model, a piece of apparatus, or does a fine job with a term paper, is encouraged to present it before the class; he is supposed to be able to answer questions regarding his work. It is definitely a worthwhile educative experience for the individual and his classmates.

Many students prefer to hand in term papers to other projects. Here is an unlimited field of subjects for students to do research in and to write about. Numerous topics can be selected from the history of chemistry: general, organic, physical, biological, and electrochemistry; basic chemical industries; industrial products; chemistry and hygiene; chemistry in the home and the community; chemistry in national defense; chemistry and human progress; the role of chemistry in many aspects of personal, daily life; etc. However, certain standards must be set for written projects in order to prevent students from thinking of them as a "snap" and as an easy way of meeting the requirement of earning a better grade. The student should choose a topic in which he has a definite interest; he should do research on it until he has it well at hand before setting it down in writing; the theme should be presented in a readable and understandable form, with due credit to sources; and, whenever possible, it should contain illustrative material, such as charts, tables, pictures, drawings, etc. Physically, it should be a neat job, with an appropriate cover, title page, table of contents, chapters or units, and a bibliography. And, most important, the student should be able to give a

summary of his work before his classmates and answer questions that may arise.

The quality and the value of the term paper naturally depend on the kind of student who is doing it. Many papers are poor, but frequently some very excellent ones come through which are a source of satisfaction to the teacher and the student. This author was fortunate enough to read many papers which were good enough to be used on a college level and, when summarized, gave the listeners basic and interesting chemical information and an appreciation of the role of chemistry in their life.



A much smaller percentage of students choose for their project the construction of models, charts, or demonstration apparatus. These usually illustrate a chemical principle, process, concept, or application to modern life. Here the student may plan and carry out his own purposeful and self-directed activity and develop both his academic and mechanical skill. He may choose any one of the 60-odd suggestions listed by the instructor or from the excellent compila-

tions in the *Journal of Chemical Education*[2] (these he has to look up in the Technological Department of the Public Library), or he may come up with an idea of his own which will satisfy his interest in the subject.

A few of the models and charts made during the second semester, February–June, 1951, are shown in the accompanying pictures. Figure 1 represents an enlarged reproduction of a black and white chart which appeared in the *Journal of Chemical Education* of April, 1951. However, the student used colors to emphasize relationships between elements of the same group and of families within the group. This chart and the "tower" arrangement of the periodic table,[3] Figure 2, have become very useful teaching tools to give the students a better understanding of a fundamental concept in chemistry. Incidentally, the students who submitted these projects explained them to their classmates in a very satisfactory manner.

Figure 3 shows one of ten models representing the electronic structures of atoms (hydrogen through neon). In the nucleus, the protons are represented as small red clay spheres and the neutrons as blue ones of equal size. The electrons, larger balls of brown clay, can be seen in their K and L shells, each electron in an orbit of its own. The idea for this project was taken from an article and colored drawings in *Life*. As a visual aid in teaching the electron structure of the atom, there are few which will surpass it.

Figure 4 shows a favorite among charts: Products obtained from the destructive distillation of soft coal. I have several variations of this project and use them effectively as background material when this subject is discussed in class.

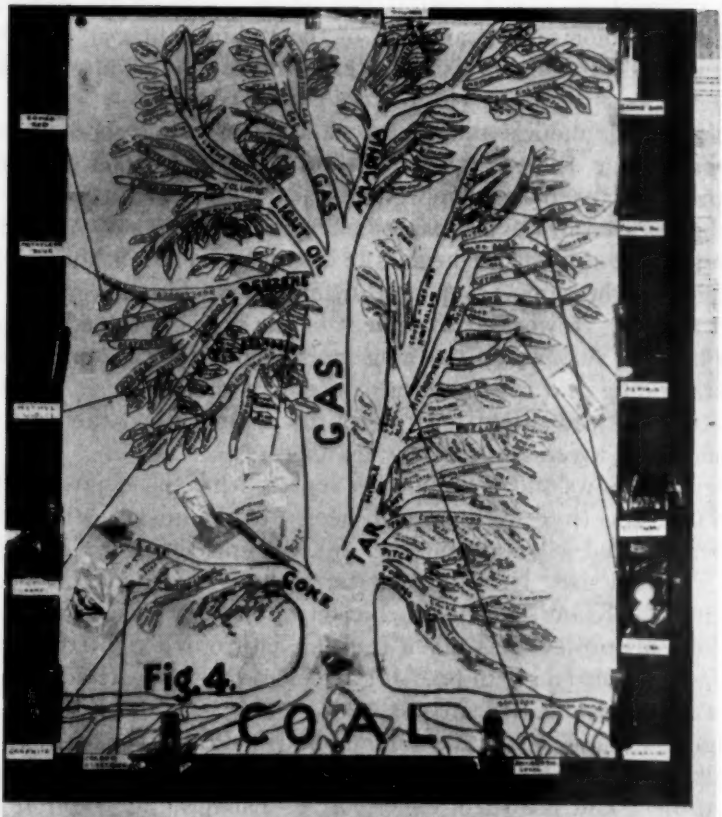
Figures 5 and 6 show models and a diagrammatic drawing of the Frasch process for extracting sulfur. Other projects which were handed in included: a model of a soap factory operated by a student's father, another of a father's dry cleaning plant, a model which illustrates the manufacture of sulphuric acid by the contact process, cardboard models which illustrated the crystalline forms of various substances, a display of common and useful alloys, models of a Bessemer converter, blast furnace, acid-soda and foamite fire extinguishers, a photoelectric cell, a cut-away of a modern charcoal plant, and many others. The important aspect of all of them is 1) that each project was executed carefully and presented understandably before the class and 2) that each project remained with the teacher as an extremely useful teaching device.

The third type of projects, preferred by some students, are experi-

---

[2] See bibliography at the end of this article.

[3] This model was constructed from plans which appeared in *Popular Mechanics* (I believe) by a student of Mrs. Margaret Teal, a colleague of the author, now teaching at Mumford High School, Detroit.


GAS
LIGHT OIL
AMMONIA
TAR
COKE
Fig.4.
COAL

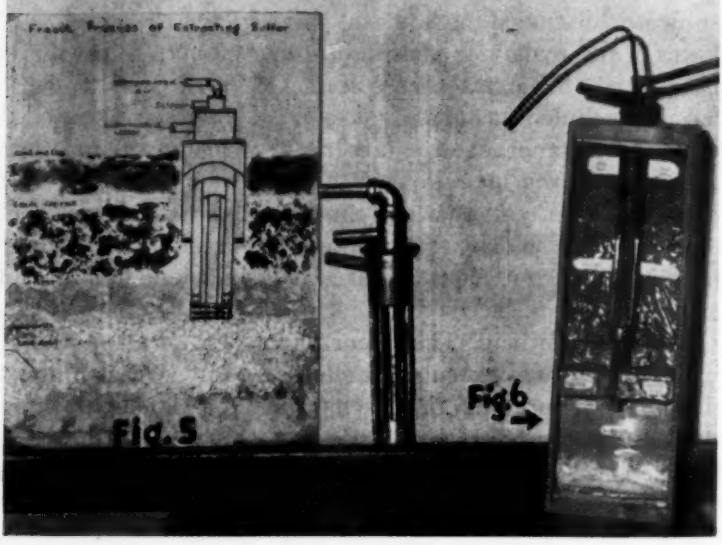


Fig.5
Fig.6

ments and demonstrations. For these I provided a list of possible experiments, keeping in mind the limitations of the students' chemical background, available time and space, and the possibility of teacher supervision. The last item is extremely important, for there is probably a no more potentially dangerous place than a chemistry laboratory with high school students working in it without constant supervision. Therefore, arrangements had to be made with the students to come in for their individual experimentation at a time when this author could give them supervision and attention.

I recall clearly two enthusiastic students who put this teacher's nerves to a severe test. One was working on making matches. After some unsuccessful trials in making a smooth, workable head from potassium chlorate and antimony sulfide, he decided—without consultation or approval—that grinding the two chemicals in a mortar with a pestle would give a more homogeneous and better mixture. The explosion which resulted shook the whole wing of the school, and the cry "my eyes! my eyes!" which followed unnerved the teacher and the students in the laboratory. Fortunately, this student suffered only a superficial hemorrhage of surface blood vessels and he returned to the laboratory on the next day a little subdued but ready to continue with his experimentation. There will be no more match-making as far as this teacher is concerned!

The other boy worked on a chemical volcano. Everything in the trial demonstrations was supervised and went off well. But on the day of the demonstration, he managed to slip into the mixture a few more chemicals, to make his volcanic eruption more "real," and then proceeded to literally stick his nose into the cone to see why the explosion did not come off. The teacher, fortunately, kept the students at a distance, including the demonstrator, and was he relieved when he found everybody and everything all right after a terrific eruption!

Barring these two incidents, the other demonstrations, which were tried out in advance, created real interest and gave the students a sense of achievement hardly matched by other activities. One of the finest and most instructive demonstrations was given by one boy on the liquefaction of gases: the historical background, present-day methods, and a demonstration on the liquefaction of SO_2 and the properties of the liquid. Another one was devoted to photography: the camera, the photographic process, the film and the chemical change it undergoes, developing, printing, enlarging, color photography, etc.—a continuous demonstration with interesting running commentary. These were considered so good that both boys were

asked to give their demonstration before the teacher's other classes and were invited by another teacher to do the same.

Other demonstrations included: preparation of inks, cosmetics, soap, and paints; fractional distillation of petroleum; methods of stain removal; qualitative analysis for metallic ions (we do not take it up in regular laboratory); and many others.

Another type of project, limited in its application, but very rewarding in nature was entrusting the students with the care of the hall exhibit case. Theirs was the responsibility of preparing and arranging one exhibit. This required preparation, skill, thoughtful arrangement, instructive labeling, interesting background, and an attractive display. Exhibits prepared and displayed by students included one on rubber, one on leather, one on alloys used in the household, and one on the elements and their uses.[4]

In summary, projects—in all the various forms—may be used dramatically and effectively to supplement the text, class and laboratory work by appealing to more students, stimulating them to develop a greater interest in the subject, offering opportunities for creative channeling of youthful energy, and making the course a little more functional and practical. The teaching of high school chemistry may definitely be enriched by the appropriate use of project ideas and materials.

Bibliography

High School Chemistry Projects

1. Science Projects by W. R. Moline. *Journal of Chemical Education*, Vol. 17, No. 8, August, 1940. Pp. 389–394, 206 projects in chemistry, physics and general science listed.
2. 101 High School Chemistry Projects by J. O. Derrick. *Journal of Chem. Ed.* Vol. 17, No. 10. October 1940. Pp. 492–494.
3. Project Teaching in High School Chemistry by William C. Curtis. *Journal of Chemical Education.*
   I. Exhibits and Posters. Vol. 18, No. 6, June 1941. Pp. 293–295.
   II. Models and Demonstration Apparatus. Vol. 19, No. 10. October 1942. Pp. 458–459.
   III. Problematic and Socialized Projects. Vol. 21, No. 11. November 1944. Pp. 547–550.
4. Simple Projects for Beginners by Charles H. Stone. *Journal of Chem. Ed.* Vol. 22, No. 3, March 1945. Pp. 136–147.
5. A Bibliography of (158) Chemistry Projects and Demonstrations by J. O. Derrick 1940–1949. *Journal of Chem. Ed.* Vol. 27, No. 10, October 1950. Pp. 562–564.

Professional Journals in which Project Materials, Teaching Techniques, Course Content, and other Articles on Teaching High School Chemistry May Be Found

[4] For a discussion on the subject of hall case displays, see the author's articles: "Science Exhibits," *Journal of Chemical Education*, January, 1951, p. 27, and "Science Exhibits," *Metropolitan Detroit Science Review*, May 1950, pp. 30–31.

Journal of Chemical Education, Published by Division of Chemical Education of the American Chemical Society, Easton, Pa. Subscription—$3.00 per year.
The Science Teacher, Journal of the National Science Teachers Ass'n. 1201 Sixteenth St. Washington 6, D. C. Sub.—$3.00 per year.
SCHOOL SCIENCE AND MATHEMATICS, Published by the Central Ass'n. of Science and Mathematics Teachers. P.O. Box 408, Oak Park, Ill. $3.50 per year.
Metropolitan Detroit Science Review, Official Publication of the Met. Det. Science Club and the Physics-Chemistry-Astronomy Section of Mich. Schoolmasters Club. 3437 Oakman Blvd. Detroit 4, Mich. $1.50 per year.

OUTLINE OF THE HISTORY OF GEOMETRY

GEORGE E. REVES
The Citadel, Charleston, S. C.

I. *The Period before 1600.*
  A. *The Ancient Period* (3100 B.C.–1 B.C.).
    1. *Babylonian:* records in cuneiform script on tablets of about 3000 B.C. and 2000 B.C.; areas of rectangles (3000 B.C.); areas of right triangles, trapezoids, circles (used $\pi=3$); volumes of rectangular parallelopipeds, right circular cylinders, frustum of cone (incorrect); circumferences of circles; tables of Pythagorean numbers; tables for csc x for x from 31° to 45°; proportionality of corresponding sides of similar triangles; angle in semi-circle a right angle; perpendicular from vertex to base of isosceles triangle bisects the base; applications to astronomy, earthwork, excavation of irrigation canals.
    2. *Egyptian:* records in picture writing in Moscow papyrus (1850 B.C.) and Rhind papyrus (1650 B.C.) contain 26 geometric problems; divided land into quadrilaterals; areas of triangle ($\frac{1}{2}bh$), circle (4th power of $\frac{8}{9}$ for π); volumes of right circular cylinder, square pyramid, frustum of square pyramid; cotangents of pyramid angles; applications to pyramids, obelisks, timepieces, astronomy; no evidence of knowledge of even a particular case of Pythagorean theorem in spite of possible use of 3, 4, 5 right triangle in surveying.
    3. *Chinese* (Probably contemporaneous with Babylon and Egypt): records in Ten Classics of period about 1112 B.C. to 256 B.C., written on paper about 618 A.D. to 907 A.D.; special cases of Pythagorean theorem (1100 B.C.); areas of triangle, segment of circle, rectangle, trapezoid; several formulas for area of circle (used 3 and $\sqrt{10}$ for π, in 5th century A.D. used 22/7 and 355/113, the latter not known in the West until 17th century); volumes of prism, cylinder,

pyramid, truncated pyramid and cone, tetrahedron and wedge.

4. *Hindus:* no pre-Christian records; construction of squares and rectangles, relation of the diagonal to the sides, equivalent rectangles and squares, equivalent circles and squares (used $\pi = 3.088$); Pythagorean theorem; geometry mainly mensuration without proofs, probably influenced some by Greek and Chinese geometry. The Hindu *Aryabhata* (early 6th century A.D.) gave area of isosceles triangle, incorrect volumes of pyramid and sphere, remarkable value of π as 3927/1250.

B. *The Greek and Roman Period* (600 B.C.–600 A.D.). The science of geometry began in Greece.

1. *Thales* (624 B.C.–547 B.C.): circle bisected by any diameter; base angles of isosceles triangle equal; vertical angles equal; two triangles congruent if two angles and a side in each are equal respectively; angle in semi-circle a right angle; used deductive method; applications to distance of ship from shore and height of pyramid.
2. *Pythagoras* (569 B.C.–500 B.C.) (Pythagorean School until 350 B.C.): pupil of Thales; first to study geometry for its own sake; properties of parallels; two right angles in a triangle; sums of exterior and interior angles of a triangle; transformation of areas applied to find real roots of quadratic equation; theory of proportion for commensurables, properties of similar figures; three regular solids—the tetrahedron, cube and duodecahedron; discovered incommensurables with Pythagorean theorem; believed geometry furnished true picture of material world; thought planets moved in independent circles; stellar pentagon was his society's badge.
3. *Hippocrates* (450 B.C.): indirect proof; first Greek textbook on mathematics; used letters at angles of geometric figures; reduced duplication of the cube to finding two mean proportionals between lengths a and $2a$; in trying to square the circle, was first to find curvilinear areas by ruler and compass construction of circular arcs equal to known areas; probably gave axion of continuity.
4. *Antiphon* (430 B.C.) and *Bryson* (5th century B.C.): area of circle by increasing number of sides of inscribed polygons (Bryson used inscribed and circumscribed polygons).
5. *Zeno* (495 B.C.–435 B.C.): severely criticized reasoning of mathematicians.

6. *Hippias* (425 B.C.): trisected an angle with the quadratrix.
7. *Archytas* (400 B.C.): duplicated the cube with a 3-dimensional construction.
8. *Democritus* (460 B.C.–370 B.C.): volume of triangular pyramid generalized to one on any polygonal base; volume of cone.
9. *Plato* (429 B.C.–348 B.C.): accurate definitions, limited number of postulates, definite bounds to plane geometry (only constructions by unmarked ruler and compass in elementary geometry); school of Plato studied the 5 regular polyhedra and introduced the analytic and indirect methods of proof; not known that Plato made any mathematical discovery.
10. *Theaetetus* (375 B.C.): probably first to construct all five regular solids theoretically, discovered octahedron and icosahedron.
11. *Eudoxus* (408 B.C.–355 B.C.): pupil of Plato; axiom of continuity; extended theory of proportion to answer objections of Zeno; doctrine of similar figures; problem of golden section; applied exhaustions to mensuration of solids; first text on methods of mensuration of solids; probably showed areas of two circles are to one another as squares of their diameters and volumes of spheres are to each other as the cubes of their diameters; first rigorous proof of volumes of cone and pyramid.
12. *Menaechmus* (375 B.C.–325 B.C.): pupil of Plato; discovered the conics (parabola, ellipse, hyperbola); new solution of the duplication of the cube with the parabola and hyperbola.
13. *Dinostratus* (350 B.C.): used quadratrix to square the circle; first extant indirect method proof.
14. *Eudemus* (335 B.C.): author of first story of mathematics.
15. *Aristotle* (384 B.C.–322 B.C.): encouraged applications and history of geometry; axioms of contradiction and excluded third which contributed to logical foundations for indirect proof (used in method of exhaustions); first to say division by zero impossible.
16. *Euclid* (365 B.C.–275 B.C.): treatise in 13 books, called the Elements, devoted largely to plane geometry has formed the basis of most elementary texts since then; over a thousand editions since first one published (1482); 465 propositions include most of plane and solid geometry of

American texts today; postulate of parallels (differentiates Euclidean from non euclidean geometry); proofs in excellent logical form; theory of proportion for commensurables and incommensurables; theory of numbers; regular solids; geometric proofs of algebraic identities; geometric solution of quadratic equation; no approximations of irrational numbers.

17. *Aristarchus* (3rd century B.C.): first to say earth and other planets revolved about sun (17 centuries before Copernicus).
18. *Nicomedes* (240 B.C.): used concoid to trisect an angle.
19. *Archimedes* (287 B.C.–212 B.C.): axiom of continuity; used his spiral to square the circle; estimated π between 22/7 and 223/71; areas of parabola, curvilinear figures and curved surfaces; constructed regular heptagon; volumes of geometric solids bounded by curved surfaces; by methods similar to integration found area of spiral, surface and volume of sphere, volumes of segments of solids of revolution of second degree; used mechanics as aid to discover results in geometry; center of gravity of various areas and solids; invented hydrostatics; area of triangle in terms of sides; constructed 14 inscribable semi-regular polyhedra; solved 3-term cubic with parabola and hyperbola; wrote on the construction of a sphere to imitate motion of sun, moon and 5 planets (greatest mathematician before Newton).
20. *Eratosthenes* (276 B.C.–195 B.C.): accurate determination of polar circumference of the earth.
21. *Apollonius* (260 B.C.–200 B.C.): 8 books on conics (7 extant) had systematic treatment of conics that greatly influenced later texts in analytic geometry; tangents and normals to conics; used conics in performing other constructions (problems related to maxima and minima and roots of fourth degree equations—did not determine conic by 5 points); most important properties of foci of ellipse and hyperbola (not parabola); introduced names parabola, ellipse, hyperbola; considered describing circle tangent to three given circles.
22. *Diocles* (180 B.C.): used cissoid to duplicate the cube.
23. *Heron* (75 A.D.): (perhaps Egyptian) encyclopedic writer on mathematics and physics aimed at practical utility; geometric proof of area of triangle in terms of sides; approximate measures by geometry; volumes of 5 regular

solids and anchor ring; blended Greek, Egyptian and Babylonian methods.

24. *Menelaus* (100 A.D.): defined spherical triangle; theorem for sphere, formulae equivalent to those of spherical trigonometry; projective property of the anharmonic ratio; material treated in Euclidean tradition.
25. *Pappus* (300 A.D.): writings covered all of Greek geometry; proved the important Pascal projective geometry theorem; cross cratio invariant by perspective projection; generalized Pythagorean theorem; four-line locus; volume of revolution equals product of area of generating figure and circumference made by center of gravity; constructed conic through 5 points; focus-directrix properties of conics; circle greater than any regular polygon of equal contour; sphere greater than any of five regular solids of equal area; collection of works necessary for mathematician to be fully equipped for work in geometry.
26. *Theon* (390 A.D.): edition of Euclid's Elements and commented on works of Euclid and Ptolemy.
27. *Proclus* (410 A.D.–485 A.D.): gave Ptolemy's attempt to prove the parallel postulate and made an attempt of his own; recounted works of previous mathematicians (one of main sources for history of elementary geometry).

C. *The Hindu, Arabic, Persian Period* (600–1200).

1. *Brahmagupta* (early 7th century, Hindu): distinguished between approximate and exact areas; extended Heron's area of triangle to area of a quadrilateral inscribed in a circle; important results on cyclic quadrilaterals; volume of frustum of pyramid.
2. *Mahavira* (9th century, Hindu): Heron's formula, extension of Brahmagupta; area of equilateral triangle as $\frac{\sqrt{3}}{4}a^2$.
3. *Al-Khowarizmi* (850, Arabian): sections on geometry and geometrical solutions of quadratics in his algebra.
4. *Abu'l Wefa* (940–998, Arabian): constructions with ruler and a fixed opening compass (not a real limitation).
5. *Al-Karkhi* (1010, Arabian): mensuration of surfaces and solids by Greek methods.
6. *Omar Khayyam* (1045–1123, Persian): solved cubics with intersecting conics but thought quartics geometrically unsolvable.
7. *Bhaskara* (born 1114, Hindu): Pythagorean theorem shown by similar triangle method (unknown in Europe

until Wallis (1616–1703) discovered it); used 22/7 and 3927/1250 for π; volume of frustum of pyramid.

D. *The Period 1200 to 1600.*

1. *Nasir-Eddin* (1201–1274, Arabian): attempted proof of the parallel postulate.
2. *Leonardo of Pisa* (1175–1250, Italian): text (1225) had a vast amount of material in geometry and trigonometry showing influence of travel in Greece, Egypt, Syria, Sicily and France; tried to prove the impossibility of a geometrical construction by ruler and compass of root of a cubic (nothing like this again until 19th century).
3. *Vieta* (1540–1603, French): applied algebra to geometry thus laying a foundation for analytic treatment; relation between problem of trisection of an angle and solution of a cubic equation.

II. *The Period after 1600.*

A. *The Seventeenth Century.*

1. *Kepler* (1571–1630, German): suggested (1604) principle of continuity; three plantary laws; discovered 2 of 4 known star polyhedra; studied problem of filling space with regular figures; determined conic if vertex, axis through it and arbitrary tangent with its point of contact are given; said parallel lines meet at infinity.
2. *Cavaleri* (1598–1647, Italian): gave (1629) non-rigorous method of indivisibles (published, 1635).
3. *Desargues* (1593–1662, French): treatise (1639) on conics; fundamental theorems of synthetic projective geometry (developed further in 19th century).
4. *Pascal, B.* (1623–1662, French): conics, Pascal projective geometry theorem, studied cycloid (father studied limacon).
5. *Mohr* (Dane): gave (1672) basis of proof that all constructions with ruler and compass could be done with compass alone (this proved 125 years later by Mascheroni).
6. *Descartes* (1596–1650, French): began (1637) excellent algebraic symbolism applied to geometry (analytic geometry); first to give $F+V=E+2$ for the faces, vertices and edges of a convex polyhedron.
7. *Barrow* (1630–1677, English): (taught Newton) published (1655) edition of Euclid's Elements in Latin and in English (1660); published (1669) important book on optics and geometry; new methods for areas and tangents of curves; edition (1675) of conics of Apollonius and extant works of Archimedes and Theodosius.

8. *Huygens* (1629–1695, Dutch): made discoveries with aid of ancient Greek geometry; obtained Archimedes' approximation of π by inscribing a hexagon in a circle, gave π to 9 places with a regular polygon of 60 sides; constructed (1656) first pendulum clock; gave (1673) theory of evolutes of curves; isochronous property of cycloid, theory of isochronal pendulum; equation of catenary for suspended flexible chain.
9. *La Hire* (1640–1718, French): had (1679) three dimensional analytic geometry in hand but did not develop it; treated (1685) conics by synthetic projective methods.
10. *Newton* (1642–1727, English): improved analytic geometry; tangents to curves; classified cubics; used (1687) principle of universal gravitation and gave results (obtained by calculus) in the language of Greek geometry; many results in physics and astronomy as well as in mathematics (one of greatest mathematicians of all times).

B. *The Eighteenth Century.*

1. *Parent* (1666–1716, French): first to develop (1700) general methods in three dimensional analytic geometry.
2. *Clairaut* (1713–1765, French): important advance (1731) of solid analytics (particularly with curves) and solid analytics placed (1732) on firm basis by the study of surfaces by J. Hermann.
3. *Saccheri* (1667–1733, Italian): tried (1733) to prove Euclid's geometry, with its postulate of parallels, is the only one possible (by denying the postulate); actually proved theorems in two new geometries, each as sound logically as Euclid's, thus vindicating the strict deductive method of Euclid.
4. *Euler* (1707–1783, Swiss): transformation of coordinates in solid analytics; first real start (1760) of differential geometry with study of lines of curvature; proved (1765) orthocenter, circumcenter and centroid of a triangle are collinear.
5. *Lambert* (1728–1777, German): extended Saccheri results and noted (1766) sphere is realization of one of his geometries.
6. *Monge* (1746–1818, French): invented (1763) adequate descriptive geometry in a fortifications problem (published, 1795–6); developed (1781) general theory of curvature and applications to quadric surfaces; solved partial differential equations with theory of surfaces.

C. *The Nineteenth Century.*

1. *Gauss* (1777–1855, German): had (1800) main results of hyperbolic geometry but did not publish them or claim priority for noneuclidean geometry (results found in his papers after his death); systematic study (1827) of quadratic differential forms in two variables to investigate the curvature of surfaces, applications (1843, 1847) to geodesy: analytic application (1833) of topology to electromagnetism (predicted importance of topology).
2. *Carnot* (1753–1823, French): tried (1806) to show pure geometry as powerful as analytic methods, derived many projective geometry theorems.
3. *Poncelet* (1788–1867, French): gave (1822) new life to projective geometry, introduced line at infinity; tried to show superiority of synthetic methods, obtained many geometric theorems with astonishing facility; used a principle of continuity not acceptable to analysts [principle generalized (1874–9) by Schubert (1848–1911, German) and his methods used by Chasles (1793–1880, French), Steiner (1796–1863, Swiss), Cayley (1821–1895, English) and Zeuthen (1839–1920, Danish)].
4. *Gergonne* (1771–1859, French): first to clearly state (1825–7) the important principle of duality.
5. *Mobius* (1790–1868, German): introduced (1827) homogeneous coordinates; analytic projective geometry; helped (1863) characterize closed surfaces by topologic invariants; independent discovery of principle of duality.
6. *Lobachewsky* (1793–1856, Russian): published (1829) complete system of hyperbolic noneuclidean geometry (first paper (1826) was lost).
7. *Bolyai* (1802–1860, Hungarian): published (1833) his system of hyperbolic geometry (said to have been convinced (1825) hyperbolic geometry was consistent).
8. *Steiner* (1796–1863, Swiss): introduced (1824) powerful method of inversion; unified (1832) classical methods of pure projective geometry and solved special problems (greatest pure geometer since Apollonius).
9. *von Staudt* (1798–1867, German): gave (1847–1860) a purification of geometry showing it could get along without analysis.
10. *Plucker* (1801–1868, German): introduced (1831) concept that generalizes duality by considering the dimensionality of space as dependent upon the basic space-elements; classified (1839) curves of fourth order; homogeneous co-

ordinates; presented (1865) line geometry which is applied in the dynamics of rigid bodies; important equations connecting order, class, numbers of double points, double tangents and points of inflection of algebraic plane curves; abandoned visual intuition for analysis which finished for geometry what noneuclidean geometries had partially done.

11. *Wantzel* (1814–1848, French): showed (1837) cubic equations irreducible in the Euclidean domain and hence it is impossible to solve by ruler and compass the problems of trisection of an angle and the duplication of the cube.
12. *Grassmann* (1809–1877, German): introduced (1844) notion of n-dimensional space and n-dimensional complex numbers.
13. *Cayley* (1821–1895, English): gave (1843), independently of Grassmann, a sketch of a geometry of n-dimensions; invented line coordinates independently of Plucker; reduced (1859) metric geometry to projective geometry (details for plane geometry only).
14. *Riemann* (1826–1866, German): invented (1854) a spherical geometry giving a realization of one of Saccheri's geometries, the space is unbounded but finite and any two straight lines intersect twice (has no parallels); introduced realization of elliptic noneuclidean geometry on a hemisphere (this gave the three classical types of noneuclidean geometry, hyperbolic, elliptic and spherical-Euclidean is called parabolic); generalized quadratic differential form in 2 variables of Gauss to n variables in his foundations of geometry (generalizes Pythagorean theorem and curvature to any space of n dimensions); study of Riemann surfaces showed significance of topology.
15. *Beltrami* (1835–1900, Italian); showed (1868) pseudosphere realizes the type of hyperbolic geometry, that it is a surface of constant negative curvature and the spherical geometry is a surface of constant positive curvature (convinced mathematicians all four types of geometry true).
16. *Christoffel* (1829–1900, German): aided (1869) development of differential geometry in transformations of quadratic differential forms; invented covariant differentiation; made steps toward development of tensor calculus (theory of relativity uses differential geometry and tensors).
17. *Lie* (1847–1899, Norwegian): developed group transformations with distance invariant; showed that under a

certain condition only four types of 3-dimensional spaces possible.

18. *Klein* (1849–1925, German): introduced (1871) unification of different geometries whereby the geometries of Lobachewsky and Bolyai, Riemann, and Euclid are determined by the absolute being real, imaginary, or degenerate; instituted (1872) program of synthesis whereby transformation groups provided the means for unifying all special theories of geometry of that time.
19. *Cantor* (1845–1918, German): conceived (1879–84) any geometric configuration as a set of points in Euclidean space (this aided analytic development of topology with the generalization (1906) to abstract spaces by Frechet).
20. *Pasch* (1843–1931, German): presented (1882) geometry as a deductive science completely determined by original postulated relations (profoundly influenced conception of geometry).
21. *Lindemann* (1852–1939, German): proved (1882) the impossibility of ruler and compass solution of the problem of squaring the circle with his proof that π is transcendental.
22. *Peano* (1858–1932, Italian): attempted (1888) to reduce all mathematics to a precise symbolism with proofs based on explicitly stated sets of postulates intended to be necessary and sufficient for the proofs; with several collaborators (1891–5) recast much of mathematics in his new symbolism.
23. *Hilbert* (1862–1943, German): completely established (1899) the postulational method in geometry; showed Euclid's postulates were not adequate for the logical development of Euclidean geometry; gave a set of explicit assumptions from which the propositions of ordinary geometry follow by purely logical processes (simpler systems have since been worked out in this country by Veblen and Huntington).

D. *The Twentieth Century.* The methods of synthetic metric geometry were revivified into something new by the ideas of analytic geometry in the seventeenth century, by those of projective geometry in the seventeenth and nineteenth centuries, by those of differential geometry in the eighteenth and nineteenth centuries. Lemoine (1840–1912) and Brocard (1845–1922) attempted a revival of elementary geometry with a study of the geometry of the circle and the triangle. However, in pure mathematics, much of

the geometry of the nineteenth century has been thrust aside by the more vigorous geometries of abstract spaces and the non-Riemannian geometries developed in the twentieth century. In 1911 Brouwer opened a new era in topology with the proof that the dimensionality of a Cartesian space is a topologic invariant, with his postulational basis for point sets and with a critical revaluation of all mathematical reasoning (his objections may be compared with those of Zeno). Topology is so unlike previous mathematics that it hints of a major transition and may be the germ of the mathematics of the future. Weyl constructed in 1918 the first non-Riemannian geometry in an attempt to get a unified field theory including Einstein's gravitational field and Maxwell's electromagnetic field, and this has led to innumerable developments in abstract spaces not included in the synthesis of Klein.

THE ELEMENTARY SCHOOL SCIENCE LIBRARY FOR 1950–1951

PAUL E. KAMBLY

School of Education, University of Oregon, Eugene, Oregon

This is the eighth yearly list of reference books for elementary school science compiled and published in SCHOOL SCIENCE AND MATHEMATICS. The purpose, like that of preceding lists, is to suggest to elementary school teachers, books that are supplementary to basic text series either for their values as sources of information or for recreational reading. Certain books, included primarily because of assumed value as recreational reading are below desired standards of good sources of science information. The sub-division topics are of no significance except as an aid in grouping the references.

The grade levels indicated are the lowest in which it is recommended that the books be used. Exact grade placement is difficult because of variations in pupil reading ability as well as differences in how the books are used. The recommendations and the brief annotations are based on an examination of each book listed.

REFERENCE BOOKS FOR ELEMENTARY SCHOOL SCIENCE

Animals

(See also list of books on birds)

	Grade	*Price*
Billy Buys a Dog. By E. L. Stewart. 44 pp. '50. Reilly[1].....	1	$2.00

This is a science reference only in the sense that small chil-

[1] Publishers and their addresses are listed at the end of this section.

	Grade	Price
dren can actually read about Billy buying a pet. The pictures are very good.		
Garden Spider. By Mary Adrian. 38 pp. '51. Holiday. This is an account of the garden spider, from the time it is hatched until it lays eggs and dies. It has large type and colored illustrations.	2	$2.00
Forest Animals and How to Draw Them. By Amy Hogeboom. 39 pp. '50. Vanguard. This book includes photographs and directions for drawing the fawn, beaver, rabbit, fox, weasel, skunk, squirrel, opossum and elk.	3	1.75
Golden Hamsters. By Herbert S. Zim. 64 pp. '51. Morrow. This is the ninth science picture book written by the same author. This book tells how to care for hamsters. It should be an excellent reference for any classroom that has animal pets.	3	2.00
Hop, Skip, and Fly. By Irmengarde Eberle. 62 pp. '51. Holiday. This is a reissue of a group of nature stories about a frog, scorpion, bat, stickleback, garter snake, lizard, and snail.	3	2.00
Sea Animals and How to Draw Them. By Amy Hogeboom. 39 pp. '51. Vanguard. This is one of a series of similar books. It includes the dolphin, whale, polar bear, turtle, shark, walrus, penguin, crocodile and seal.	3	1.75
Strange Sea Life. By G. V. Robertson and Vera Graham. 115 pp. '50. Holt. A book written to arouse interest in the unusual kinds of fish found in the oceans. There is a drawing of each kind of fish described in the book.	3	2.50
Stripe—The Story of a Chipmunk. By Robert M. McClung. 64 pp. '51. Morrow. This is another well written and beautifully illustrated animal story. The text is set in large, easy-to-read type.	3	2.00
The Great Whales. By Herbert S. Zim. 64 pp. '51. Morrow. This is the eighth book of the excellent science picture books written by Dr. Zim. This book answers questions such as, "Do whales have hair? How deep can they dive? Do they see and hear under water? How fast can they swim? What enemies do they fear?"	3	2.00
Thunder Wings—The Story of A Ruffed Grouse. By Olive L. Earle. 64 pp. '51. Morrow. This is a well written story with good illustrations. It begins when "Little Ruff" hatches from an egg and ends when he finds his mate the following spring.	3	2.00
Let Them Live. By Dorothy P. Lathrop. 80 pp. '51. Macmillan. A book that can be used in conservation units. The author emphasizes "Let Them Live" and makes no mention of wise use of natural resources.	4	2.00
Animal Tools. By George F. Mason. 94 pp. '51. Morrow. This is the fifth book of a series by Mr. Mason. Some of the chapter titles are Feet as Tools, Insect Drills, Chisels and Knives, The Bee's Tool Kit, The Fly's Gyroscope and Mosquito Surgery. There are 13 chapters in all.	6	2.00
Adventures with Reptiles. By C. J. Hylander. 174 pp. '51. Messner. This is the story of Ross Allen who owns and operates the Reptile Institute in Silver Springs, Florida. It includes the story of antivenin and practical uses of snake venom.	6	2.75

Birds

	Grade	Price
Beginner's Guide to Attracting Birds. By L. A. Hausman. 127 pp. '51. Putnam. The text, illustrated with pen and ink sketches, shows how to build bird houses, feeding stations, seed trays, and other devices that will help attract birds. There is also a simple key for identifying the common species of birds.	5	$2.00

General Nature Study

If You Could See Inside. By Marie Neurath. 32 pp. '50. Chanticleer. This explains what a volcano, a molehill, an egg, a paper wasp nest and 10 other objects look like inside.	2	1.50
All Around You. By Jeanne Bendick. 48 pp. '51. Whittlesey. This book covers a variety of topics concerning the physical world. Typical headings are the sun, the moon, shadows, fog and rain, snow and birds.	3	2.00
State Birds and Flowers. By Olive L. Earle. 64 pp. '51. Morrow. All the state birds and flowers are described in this book. The descriptions are complete and the book is a useful reference on birds and flowers as well as a social science reference.	4	2.00
Outdoor Adventures. By Hal H. Harrison. 128 pp. '51. Vanguard This book includes pictures of children from 8 to 14 years of age in a variety of nature study situations. The text supplements the pictures. The text and pictures are grouped under the headings Spring, Summer, Autumn and Winter.	6	2.75

General Science

I'll Show You How It Happens. By Marie Neurath. 32 pp. '50. Chanticleer. This book explains 14 different phenomena through the use of text and diagrams. Included are how fire is used to make the engine go and how a boat can go uphill.	2	1.50
A First Electrical Book for Boys. By Alfred Morgan. 263 pp. '51. Scribners. This is a new and completely revised edition of a book originally published in 1935. A chapter on electronics has been added.	4	3.00
Everyday Weather and How it Works. By Herman Schneider. 189 pp. '51. Whittlesey. This book contains many drawings. It explains how to read weather maps and how to make a weather forecasting station as well as what causes differences in weather and climates.	4	2.75
Picture Book of Radio and Television. By J. S. Meyer. 40 pp. '51. Lothrop. An account of the invention of radio and television. The book includes suggestions for experiments that can be performed by grade school pupils.	4	2.00
The First Book of Stones. By M. B. Cormack. 93 pp. '50. Watts. This is an outstanding book for the beginning collector that fills a long felt need. It should be in every classroom library where rocks and minerals are of interest.	4	1.75
The First Great Inventions. By Lancelot Hogben (Editor). 36 pp. '51. Chanticleer. This book includes wheels, clothes, writing, steam engines, and picture projection as well as other inventions.	4	1.50

	Grade	Price
First Chemistry Book for Boys and Girls. By Alfred Morgan. 179 pp. '50. Scribners. This book is written with the point of view that chemistry can be just as much of a hobby as collecting or photography. The experiments suggested use only materials that are easy to obtain.	5	$2.75
Patterns in the Sky. By W. Maxwell Reed. 125 pp. '51. Morrow. Many teachers are already familiar with Mr. Reed's older books: *The Earth for Sam, The Stars for Sam* and *The Sea for Sam.* This book gives clear explanations with star charts showing how to find the twenty-five most familiar constellations.	5	2.50
Atoms at Work. By George P. Bischof. 130 pp. '51. Harcourt. This explains the basic principles of atomic activity and tells how they have been discovered. There are numerous line drawings that supplement the text.	6	2.25
The Spangled Heavens. By Lawrence Edwards. 128 pp. '51. Macmillan, (rev. ed.). This book, by an English author, may make a desirable addition to some of the less difficult books on astronomy by American authors.	6	1.50
Plants		
A First Book of Tree Identification. By Matilda Rogers. 95 pp. '51. Random. This is a very well illustrated book. It describes the branches, leaves and bark of approximately 30 common trees.	4	2.50
The First Book of Trees. By M. B. Cormack. 93 pp. '51. Watts. This well illustrated book describes approximately 80 common trees of both the evergreen and deciduous types.	4	1.75
How to Know the Wild Flowers. By Alfred Stefferud. 144 pp. '50. Holt. This book is of most value to anyone interested in the identification of wild flowers. It is arranged from simple flowers to the most complex.	5	2.00
Play with Vines. By Millicent E. Selsam. 64 pp. '51. Morrow. This book describes all kinds of vines. It also gives directions for simple experiments with vines. There are numerous drawings to supplement the text.	5	2.00
Plants in the City. By Herman and Nina Schneider. 96 pp. '51. Day. This book about plants is of particular interest to city dwellers. It explains how one can grow plants even under crowded city conditions. It is also a useful reference on plant growth for rural children.	6	2.50
Miscellaneous		
Milk for You. By G. Warren Schloat, Jr. 47 pp. '51. Scribners. This is a picture book that shows how cows make milk, how they are milked and how milk is handled until it reaches the consumer.	3	2.00
Kinnery Camp—A Story of the Oregon Woods. By Charlotte Baker. 215 pp. '51. McKay. This is the story of a logging camp that may be used in connection with some conservation units. The story centers around the adventures of two boys in a logging camp.	5	2.50

	Grade	Price
Boy's Complete Book of Camping. By Stanley Pashko. 204 pp. '51. Greenberg. This book on camping could have considerable influence on the science interests of boys. It includes chapters on packs and packing, shelters, camping emergencies, camp sanitation and camp grub.	6	$2.50
Milestones of Medicine. By Ruth Fox. 237 pp. '50. Random. The topics included in this book are X-ray, radium, drugs, vitamins, diphtheria toxoid, yellow fever control, insulin and penicillin.	6	2.75
O.K. for Drive-Away. By Henry B. Lent. 152 pp. '51. Macmillan. This is an excellent book on how automobiles are built. It includes some of the history of automobiles as well as rules for good driving.	6	2.50

PUBLISHERS AND THEIR ADDRESSES

Chanticleer: Lothrop, Lee and Shepard Company, Inc., 419 Fourth Avenue, New York 16, New York.
Day: The John Day Company 121 Sixth Avenue, New York 13, New York.
Greenberg: Greenberg Publisher, 201 East 57th Street, New York 22, New York.
Harcourt: Harcourt, Brace and Company, 383 Madison Avenue, New York 17, N. Y.
Holiday: Holiday House, 8 West 13th Street, New York 11, New York.
Holt: Henry Holt and Company, Inc., 257 Fourth Avenue, New York 10, New York.
Lothrop: Lothrop, Lee and Shepard Company, Inc., 419 Fourth Avenue, New York 16, New York.
Mc Kay: David Mc Kay Company, 225 Park Avenue, New York 17, New York.
Macmillan: The Macmillan Company, 60 Fifth Avenue, New York 11, New York.
Messner, Julian Messner, Inc., 8 West 40th Street, New York 18, New York.
Morrow: William Morrow and Company, 425 Fourth Avenue, New York 16, N. Y.
Putnam: G. P. Putnam's Sons, 2 West 45th Street, New York 19, New York.
Random: Random House, Inc., 457 Madison Avenue, New York 22, New York.
Reilly: The Reilly and Lee Company, Inc., 325 West Huron Street, Chicago, Ill.
Scribner's: Charles Scribner's Sons, 597 Fifth Avenue, New York 17, New York.
Vanguard: The Vanguard Press, 424 Madison Avenue, New York 17, New York.
Watts: Franklin Watts, Inc., 119 West 57th Street, New York 19, New York.
Whittlesey: McGraw-Hill Book Company, 330 West 42nd Street, New York 18, New York.

WAGES, TAXES, INCOME

United States government statistics show that from 1947 through 1950—
—industrial wages and salaries increased from $122 billion to $145 billion per year.
—corporate profits after taxes moved upward slightly from $19.1 billion to $22.1 billion.
—government spending increased from $28.8 billion to $42.1 billion.
—farm operators' net income from farming *dropped* from $17.8 billion to $13 billion.

—JIM ROE, Successful Farming

EASTERN ASSOCIATION OF PHYSICS TEACHERS
ONE HUNDRED EIGHTY-FIRST MEETING

Saturday, Oct. 20, 1951
Three P.M.

Harvard Observatory in Harvard, Mass.

Come—See the Observatory and the many instruments, hear Dr. Bok tell of the work of the Observatory, the wide angle camera, His work in South Africa (from which he has just returned), and what have you, eat your box-lunch out or indoors (depending on the weather) plenty of hot coffee (at or below cost), see Jupiter and her moons, see our own moon, see a film and hear about our sun, and a pleasant drive home in the late evening of middle autumn.

Clothing—Bring some extra warm wraps, it is cold in the Observatory very early in the evening.

Wives and other visitors—Yes, Mrs. Clish is to be with me, perhaps your wife and/or a friend wishes to come.

Lunch—Bring your own box-lunch, only you know the correct size.

REPORT OF THE ONE HUNDRED EIGHTY-FIRST MEETING OF THE E.A.P.T. HELD AT THE HARVARD OAK RIDGE OBSERVATORY IN HARVARD, MASS., SATURDAY, OCTOBER 20, 1951, AT 3:00 P.M.

This was the most unique meeting that the E.A.P.T. has ever held, for it was an afternoon, box-lunch, evening meeting without formal talks.

Dr. Bok opened the meeting somewhat after the three o'clock starting time for some of the members were late. Indeed, some of the members went to the Observatory in Cambridge, Mass., before coming to the "Ridge." The meeting was opened from the observers platform of the great telescope. It was cold in the great rotunda of the observatory, but heavy clothing and the warm welcome from the Doctor very shortly warmed our bodies, hearts and spirits for the visits in store for us.

The informal talk by Dr. Bok was short and to the point: first he made it clear that all were most welcome and that the facilities of the whole Observatory had been opened wide to the E.A.P.T.

Some of the history of the Observatory was the second part of the talk.

The Observatory was started in Cambridge, Mass., when the location was well away from the white lights of the city. The location was not of the best but it was the best possible near the University. The Observatory was moved from Cambridge to Harvard some time in 1930. The old Cambridge buildings are now used as offices, libraries, study rooms, and storage vaults. Little astronomical instrument work is done in Cambridge at present. The instruments are kept in good condition. The buildings and instruments have historical value. Some portions are still used for the popular "Open Nights" at the Harvard Observatory.

The chief instrument at the "Ridge" is the 61 inch reflector. The South African Harvard station, located at Bloemfontein, has a 60 inch reflector. These two instruments, located in the north and south hemispheres respectively, can be used together in research work. The big reflectors can be controlled most easily by the operator. A control block, on a long extension, can be used at all parts of the instrument. Slow and fast motion in both directions and of both declination and hour angle are operated by buttons.

On the floor, east of the 61 inch reflector, is a large tank, a bench, pumps and controls used in resurfacing the mirror. The mirror is coated with aluminum by evaporation. Before resurfacing, the old aluminum must be carefully removed and the surface made as near perfectly clean as is possible. Believe it or not, the best cloth for the final cleaning process was found to be some old and very well worn diapers.

The test for the condition of the new aluminum coat is interesting. A two inch

square of adhesive tape is firmly attacted to the new surface, the operator holds his breath and rips the adhesive tape from the mirror. If the aluminum stays on the glass, it is considered to be a good coat.

Numerous other instruments were mentioned in passing but the second instrument in importance seems to be the great Schmidt. With this instrument, 5 degrees of the sky can be photographed with excellent definition. This instrument is in use on every clear night.

The third instrument which seemed to capture the attention of the visitors was the seismograph. A constant record of the motion of the earth is kept both night and day, day in and day out.

After this part of the talk on instrumentation, Dr. Bok outlined the places of interest on the "Ridge," the 61 inch, the Schmidt, the 16" Metcalf, the Jewett, numerous small instruments, the seismograph, the library and plate collection, and the Agassiz Cottage, a good place to get warm, and the place at which all should meet to eat.

The E.A.P.T. members divided themselves into groups and visited in turn the places of interest. At each stop there was a short talk by a staff member and a period for questions. Everyone was very busy and the time before dusk passed all too quickly for most.

The Agassiz Cottage was really full, some seventy persons in a six room cottage is really a stunt. All found room to eat.

After supper, a film on the sun was shown and an hour or more of observations was enjoyed by all. Each person had the chance to see: Jupiter and her moons, The Great Nebula in Andromeda, The Ring Nebula in Lyra, and some Double Stars.

ALBERT R. CLISH, *Secretary*

EASTERN ASSOCIATION OF PHYSICS TEACHERS
ONE HUNDRED EIGHTY-SECOND MEETING

Saturday, Dec. 8, 1951

Joint Meeting with
New England Chemistry Association
and
New England Biology Association
at
Brookline High School, Brookline, Mass.

Program:

9:45 A.M.	Greetings, Dr. Robert S. Andree, Principal, Brookline High School.
10:00 A.M.	Panel Discussion, "Missing Enough Scientists," Dr. Eugene G. Rochow, Harvard Dr. Frederic L. Mathews, Jr., Monsanto Chemical Company
11:00 A.M.	Business Meetings Inspection of the new Science Laboratories
12:00 Noon	"Molecular Basis of Vision," Dr. George Wald, Harvard.
1:00 P.M.	Lunch, Brookline High School Lunch Room, $1.25. Reservations by Dec. 1 to Leland S. Hollingsworth Brookline High School, Brookline Mass.
2:00 P.M.	Dr. Frank Gallizio, G. F. Henblein and Bros., Subject to be announced.

REPORT OF THE ONE HUNDRED EIGHTY-SECOND MEETING OF THE E.A.P.T. HELD AT BROOKLINE HIGH SCHOOL, BROOKLINE, MASS., SATURDAY, DECEMBER 8, 1951

For the most part, this meeting was in the field of biology and chemistry. Dr. Wald showed the meeting how the theory of vision has changed in the dimensions of the operation agents to the molecular. Not only are some of the acting agents molecular but they are particular molecules of a group of similar molecules.

Unfortunately the physical arrangements at the school did not permit the talk by Dr. Gallizio to be presented as was originally planned. His talk, an after dinner talk, "The Nectar of the Gods" the story of wine, had to be presented in the school auditorium. It should have been a part of a most excellent dinner.

The first speakers came near being only a speaker. Dr. Mathews of the Monsanto Company was called only the day before to go to Germany on business for his company. Through a stroke of great fortune, Dr. Norman Sheppard of the American Cyanamid Co., expressed a wish to visit at the meeting. He was interested in the panel discussion. It was explained that the panel was depleted. Dr. Sheppard decided, because of his interest, to pinch-hit. He did a most commendable job.

The panel was opened by Dr. Rochow of Harvard. Of the some 100,000 scientists at work in our country, roughly 63,000 are in the chemical field. To this number are added each year about 2,500 graduates. The biology graduates are larger in number but the field of physics is the problem. Only about .45 of a physicist per million of population per year is added to the ranks of the scientists.

Engineers are very short at present. Only about 40,000 per year are entering the ranks. Some of these shortages are due to the rather severe shortages of the teachers. The pay of the teacher is low and therefore few are entering the teaching field and what is more important, many teachers are leaving the field for industry. Some of these will in time become scientists.

At present there are many conditions which should make for more persons entering the field, but still few enter. In fact enrollments are not up to the prewar level yet in spite of much effort to increase the numbers. Perhaps some of this is due to the publicity, after the war, that too many were entering the field. The publicity was poor for just the opposite was in need.

Perhaps another element enters the picture and tends to limit the prospective number of science entrants: research is now largely classified. There exists a situation to which there is at first examination no solution, much must be secret yet science depends on free circulation.

Four elements suggest themselves as mitigating against larger membership in the field of science:

Classified material can never contribute to science, or at least not for many years.

The classified scientist becomes a hemmed in citizen and there are those who do not like this aspect.

More money and good housing have been provided for the classified worker. There are those who do not like this for it is paternalism and possibly socialism.

Character, affiliations, and associates are constantly being investigated. There are some who do not like this.

In the last analysis we are each responsible for our every act. Each of us knows that the Golden Rule is the thing to which all should strive, yet in spite of this we spend more money to harm and destroy others so as to save our country and self.

From a psychiatric point of view, conflicts within the self develop as a result of the work demanded and the training experienced.

The second speaker on the panel, Dr. Sheppard, brought out the following points which have done their share in limiting the science majors:

Cornell's president has blasted the secondary school for its inefficiency and its softness.
Low birth rate of the depression has brought about small classes.
Science, by and large, is more difficult and fewer snap courses are available.
Witch hunts have entered the picture and kept some from the field.

What can be done about the present situation was next considered by the speaker. The answer seems to be little for the present. The country has not made the best use of the scientists in both the military and the civilian aspects. Much can be done to better the use of those available. Scientists cannot be treated as pawns except in times of a national emergency. All that can be done is to look for the future in the hope of getting more promising personnel from the secondary schools, both the teachers and the graduates. The answer seems to be in the high school: bring more students into the laboratory.

After the panel discussion, a printed sheet from the Engineering Manpower Commission of Engineers Joint Council was distributed to all. The following is a copy of the sheet.

SUGGESTED INFORMATION SHEET FOR STUDENTS IN THE 7TH TO 12TH GRADES

Help wanted: engineers

Never in American history have the opportunities for engineers been more challenging than they are today. Engineers are desperately needed for an unparalleled expansion of our peacetime industries, continued development of our national resources, and the accelerating program of mobilization for national defense. The Help Wanted advertisements in any newspaper tell this story of manpower shortage in the engineering profession.

Over 50,000 engineering graduates in 1950 found ready employment. This year there were less than 40,000 graduates and the present enrollment in the engineering colleges indicates that by 1954 the number of graduates will be less than 20,000. However, in the face of this falling trend in the number of graduates the demand for engineers continues high and is expected to remain at a minimum of about 50,000 annually for the next several years. A yearly shortage of as many as 35,000 engineers looms as a very real and alarming possibility.

Where are more engineers coming from?

There is only one answer to this question: From the boys—and girls, too—who are now in junior and senior high schools who have the natural skills, the vision, and the enthusiasm and courage which with proper training will make them the creators of the better bridges and buildings and machines and power systems which our country must produce in its new role of world leadership. Perhaps you yourself will be one of these people. Do you have the necessary qualifications?

Who will be a good engineer?

Good engineers are: INQUISITIVE—IMAGINATIVE—INGENIOUS. Are you?

The question, "How does it work?" is a natural one not only for the engineer but for the artisan and the mechanic as well. When the engineer adds, "Why does it work?" he reveals an advanced type of curiosity which sets him apart from the machine operator or technician. Are you satisfied to know How, or must you also know Why?

The engineer must visualize what he seeks to create in terms of size and form and function. He must also have the ability to deal with the symbolic language of his profession, whether it be percentages or equations, graphs or drawings. This quality of imagination should be in the make-up of every engineer. Do you have it? Do you use it?

Ingenuity or inventiveness is at the very heart of engineering.

It has been remarked that if necessity is the mother of inventions, the father of inventions is ingenuity. It is significant that the basic meaning of "engineer" is ingenius designer and that "engineer" and "ingenuity" stem from common Latin roots. The engineer who lacks the quality creativeness, is without a mainspring in his profession.

Add to these the more common characteristics of good general intelligence, industry, accuracy, and the capacity to influence and get along well with other people, and the engineer begins to emerge.

Should you think of engineering for yourself?

Yes, you should if you

1. Possess some measure of the characteristics above,
2. Are in the top third of your class,
3. Have shown particular proficiency and interest in mathematics and the physical sciences,
4. Are at least in the top half of your class in English.

Engineers need helpers, too.

For every engineer there is a need for mechanics, technicians, and technologists of one sort or another who possess some of the interests and abilities of the engineer but by no means all of them. Here, too, for years to come opportunities will abound for young men and women who can do things with their hands and crave the chance to share in the adventure of making the world a better place to live in in the beginning of this atomic age.

Your secretary has saved the greetings from the host, Dr. Andree, until the last for his remarks seem best at this time. Dr. Andree presented two question with the suggestion that his listeners do some thinking on both of them:

When did you last fail a pupil?

When did you last contribute to the success of an impossible student?

ALBERT R. CLISH, *Secretary*

PROBLEM DEPARTMENT

CONDUCTED BY G. H. JAMISON

State Teachers College, Kirksville, Missouri

This department aims to provide problems of varying degrees of difficulty which will interest anyone engaged in the study of mathematics.

All readers are invited to propose problems and to solve problems here proposed. Drawings to illustrate the problems should be well done in India ink. Problems and solutions will be credited to their authors. Each solution or proposed problem sent to the Editor should have the author's name introducing the problem or solution *as on the following pages.*

The editor of the Department desires to serve his readers by making it interesting and helpful to them. Address suggestions and problems to G. H. Jamison, State Teachers College, Kirksville, Missouri.

SOLUTIONS AND PROBLEMS

Note. Persons sending in solutions and submitting problems for solutions should observe the following instructions.

1. Drawings in India ink should be on a separate page from the solution.

2. Give the solution to the problem which you propose if you have one and also the source and any known references to it.

3. In general when several solutions are correct, the one submitted in the best form will be used.

Late Solutions

2275. *W. R. Warme, Minneapolis.*

2278. *Jesse B. Flausburg, Houston.*

2281. *Proposed by Hugo Brandt, Chicago.*

Show that tangents to the curve $x^2+y^2=x^3$ cannot have a slope between $\sqrt{3}$ and $-\sqrt{3}$.

First solution by Leon Bankoff, Los Angeles, Calif.

The curve is semi-parabolic, with an isolated point at the origin, an x-intercept at $x=1$, no y-intercepts, and having symmetry with respect to the x-axis. The curve is continuous between $x=1$ and $x=\infty$. At the x-intercept the slope of the tangent is ∞. In the first quadrant the curve is concave downward from $x=1$ to the point of inflection at $x=4/3$, and becomes concave upward as x increases to infinity. At the point of inflection the first derivative (the slope of the tangent) is $\sqrt{3}$. As the curve recedes in different directions from $x=4/3$, the slope of its tangent approaches ∞. Consequently the minimum slope of tangents in the first quadrant is $\sqrt{3}$, and the maximum slope in the fourth quadrant is $-\sqrt{3}$.

From the given equation we have:

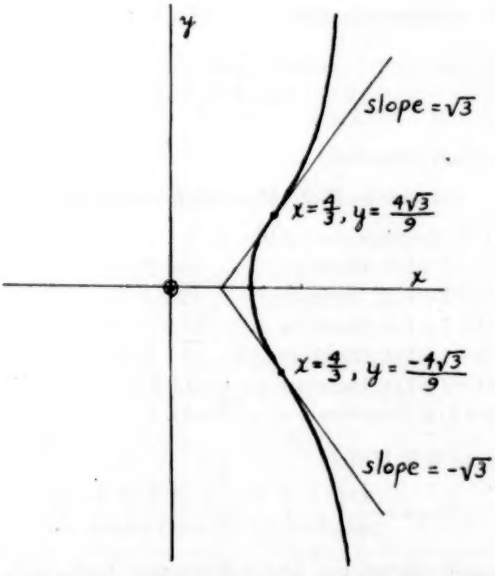
$$f(x)=\pm x\sqrt{x-1}.$$

Then

$$f'(x)=\frac{\pm(3x-2)}{2\sqrt{x-1}}$$

$$f''(x)=\frac{\pm(3x-4)}{4(x-1)^{3/2}}.$$

When $f(x)=0$, we have $x=0$ and $x=1$, giving the singularity and the x-intercept. For $x<1$, y is imaginary.



When $f'(x)=0$, we learn that the curve has no real maximum or minimum.

When $f''(x)=0$, we have $3x-4=0$. Solving for x yields the points of inflection at $x=4/3$, $y=(\pm 4\sqrt{3}/9$.

Substituting $x=4/3$ in $f'(x)$, we get $(dy/dx)=\sqrt{3}$, the relatively minimum slopes of the tangents at the point of inflection. Thus the tangents to the curve $x^2+y^2=x^3$ cannot have a slope between $\sqrt{3}$ and $-\sqrt{3}$.

Second solution by Richard H. Bates, Milford, N. Y.

In order that the slope of the tangent have a real value, we set the derivative equal to K and determine K for these real values:

$$\frac{3x-2}{2\sqrt{x-1}}=K \quad \text{or} \quad 3x-2=2K\sqrt{x-1}.$$

Squaring both sides:

$$9x^2-(2x+4=4K^2x-4K^2 \quad \text{or}$$
$$9x^2-(12+4K^2)x+(4+4K^2)=0.$$

The discriminant b^2-4ac of this equation must have a value $\geqq 0$ in order to give real values to the slope of the tangent. Hence:

$$16K^4-48K^2\geqq 0$$
$$K^2\geqq\sqrt{3}.$$

Solutions were also offered by: Francis A C Sevier, Princeton; L. H. Lange, Valparaiso, Ind.; Aaron Buchman, Buffalo; C. W. Trigg, Los Angeles City College; R. L. Moenter, Fremont, Neb.; V. C. Bailey, Evansville, Ind.; Robert R. Phelps, Los Angeles City College; and also the proposer.

2282. *Proposed by Hugo Brandt, Chicago.*

Adopting the notation for a recurring continuous fraction

$$a+\frac{1}{b+}\left[\frac{1}{c+}\right[\frac{1}{d+}\cdots$$

for the older more cumbersome notation:

$$a+\cfrac{1}{b+\cfrac{1}{c+}\cdots}$$

develop $\sqrt{19}$ into such a fraction.

Solution by R. L. Moenter, Fremont, Neb.

Let $\sqrt{19}=4+1/b$, therefore $b=(\sqrt{19}+4)/3$.
Let $(\sqrt{19}+4)/3=2+1/c$, therefore $c=(\sqrt{19}+2)/5$.
Let $(\sqrt{19}+2)/5=1+1/d$, therefore $d=(\sqrt{19}+3)/2$.
Let $(\sqrt{19}+3)/2=3+1/e$, therefore $e=(\sqrt{19}+3)/5$.
Let $(\sqrt{19}+3)/5=1+1/f$, therefore $f=(\sqrt{19}+2)/3$.
Let $(\sqrt{19}+2)/3=2+1/g$, therefore $g=\sqrt{19}+4$.
Let $\sqrt{19}+4=8+1/h$, therefore $h=(\sqrt{19}+4)/3$.

Now h is the same as b. Hence:

$$\sqrt{19}=4+\frac{\dot{1}}{2+}\left[\frac{1}{1+}\right[\frac{1}{3+}\left[\frac{1}{1+}\right[\frac{1}{2+}\left[\frac{\dot{1}}{8+}\cdots\right.\right.\right.

Oliver T. Shannon, Wheeling, W. Va.; Betty Swanson, Chicago; J. H. Means, Austin, Texas; and also the proposer.

2283. *Proposed by C. W. Trigg, Los Angeles City College.*

An arithmetic progression and its reverse are multiplied term by term. Find a general expression for the sum of the products. An example.

$$3\cdot 11+5\cdot 9+7\cdot 7+9\cdot 5+11\cdot 3=205.$$

Solution by V. C. Bailey, Evansville College, Evansville, Ind.

$$a+(a+d)+(a+2d)+\cdots+(L-2d)+(L-d)+L \tag{1}$$

$$L+(L-d)+(L-2d)+\cdots+(a-2d)+(a-d)+a. \tag{2}$$

If n is even, the sum of the products is

$$S_n=n(aL)+2[1+2+3+\cdots+(n-2)/2](L-a)d$$

$$-2\left[1^2+2^2+\cdots+\left(\frac{n-2}{2}\right)^2\right]d^2. \tag{3}$$

This may be written

$$S_n=n(aL)+\frac{1}{4}(n)(n-2)(L-a)d-\frac{1}{12}n(n-1)(n-2)d^2. \tag{4}$$

Similarly, the sum of an odd number of products is

$$S_{n+1}=n(aL)+\frac{1}{4}(n-1)^2(L-a)d-\frac{1}{12}(n-1)(n^2-2n+3)d^2. \tag{5}$$

If

$$L=a+(n-1)d$$

be substituted in (4) and (5), we arrive at one and the same formula which holds for any number of products. That is,

$$S=na^2+n(n-1)ad+\frac{1}{6}n(n-1)(n-2)d^2.$$

Solutions were also offered by: R. L. Moenter, Fremont, Neb.; Francis L. Miksa, Aurora, Ill.; Leon Bankoff, Los Angeles; Francis A C Sevier, Princeton; Richard H. Bates, Milford, N. Y.; Aaron Buchman, Buffalo; L. H. Lange, Valparaiso, Ind.; and also the proposer.

2284. *Proposed by Roy Wild, University of Idaho.*

Show that

$$\sqrt[4]{\frac{3+2\sqrt[4]{5}}{3-2\sqrt[4]{5}}}=\frac{\sqrt[4]{5}+1}{\sqrt[4]{5}-1}.$$

Solution by Robert R. Phelps, Los Angeles City College.

Multiplying inside the radical on the left by $(2+2\sqrt{5})/(2+2\sqrt{5})$ we have

$$\sqrt[4]{\frac{6+4\sqrt[4]{5^3}+6\sqrt{5}+4\sqrt[4]{5}}{6-4\sqrt[4]{5^3}+6\sqrt{5}-4\sqrt[4]{5}}}=\sqrt[4]{\frac{5+4\sqrt[4]{5^3}+6\sqrt{5}+4\sqrt[4]{5}+1}{5-4\sqrt[4]{5^3}+6\sqrt{5}-4\sqrt[4]{5}+1}}=\frac{\sqrt[4]{5}+1}{\sqrt[4]{5}-1}.$$

Solutions were also offered by: Fayette Zimmer, Bangor, Maine; W. R. Warme, Minneapolis; Betty Swanson, Chicago; R. L. Moenter, Fremont, Neb.; F. L. Miksa, Aurora, Ill.; C. W. Trigg, Los Angeles City College; Leon Bankoff, Los Angeles; and also the proposer.

2285. *Proposed by Charles McCracken, Jr., University of Cincinnati.*

Evaluate:

$$\lim_{n\to\infty} \frac{2n}{\csc \frac{\pi}{n}}.$$

Solution by C. W. Trigg, Los Angeles City College

$$\lim_{n\to\infty} \frac{2n}{\csc \pi/n} = \lim_{n\to\infty} 2\pi \left(\frac{\sin \pi/n}{\pi/n}\right) = 2\pi \lim_{n\to\infty} \left(\frac{\sin \pi/n}{\pi/n}\right) = 2\pi.$$

Solutions were also offered by: L. H. Lange, Valparaiso, Indiana; Leon Bankoff, Los Angeles; W. R. Warme, Minneapolis; Francis A C Sevier, Princeton; Richard H. Bates, Milford, N. Y.; V. C. Bailey, Evansville, Ind.; R. L. Moenter, Fremont, Neb.; Robert R. Phelps, Los Angeles City College; Harry W. Hickey, Davidson, N. C.; and also the proposer.

2286. *Proposed by Charles McCracken, Jr., University of Cincinnati.*

Show that if p is any prime, and p^2 is divided by 12 the remainder is 1.

Solution by the Proposer

The sequence $\{6n \pm 1, 2, 3\}$ includes all integers. $6n \pm 2, 3$ is always composite. Therefore the sequence $\{6n \pm 1\}$ includes all the primes. Thus p^2 may be represented by $36n^2 \pm 12n + 1$. Dividing by 12 we see that the remainder is 1.

Solutions were also offered by: R. L. Moenter, Fremont, Neb.; C. W. Trigg, Los Angeles City College; Aaron Buchman, Buffalo; L. H. Lange, Valparaiso, Ind.; Francis L. Miksa, Aurora, Ill.; Francis A C Sevier, Princeton; Leon Bankoff, Los Angeles, Calif.; Richard H. Bates, Milford, N. Y.; Sister Angela Mary, Cleveland.

HIGH SCHOOL HONOR ROLL

The Editor will be very happy to make special mention of high school classes, clubs, or individual students who offer solutions to problems submitted in this department. Teachers are urged to report to the Editor such solutions.

Editor's Note: For a time each high school contributor will receive a copy of the magazine in which the student's name appears.

2284, 5. *Robt. H. Phelps, Los Angeles.*

PROBLEMS FOR SOLUTION

2299. *Proposed by Cecil B. Read, University of Wichita.*

If $\cos \alpha + \cos \beta + \cos \gamma = 0$, and $\sin \alpha + \sin \beta + \sin \gamma = 0$, show that $\cos 3\alpha + \cos 3\beta + \cos 3\gamma = 3[\cos (\alpha + \beta + \gamma)]$.

2300. *Proposed by Hugo Brandt, Chicago.*

Given that a function

$$f(n) = \frac{3n+1}{n-3},$$

show that if $f(n) = N$, then $f(N) = n$. Find another function $g(n)$ with the same property, that is: if $M = g(n)$, then $g(M) = n$. Generalize.

2301. *Proposed by Roy E. Wild, Moscow, Idaho.*

Use the definition:

$$\ln x = \int_1^x \frac{dt}{t},$$

to show that $\ln x^2 = 2\ln x$.

2302. *Proposed by Hugo Brandt, Chicago.*

For the ellipse $(x^2/a^2)+(y^2/b^2)=1$ find the circumscribed rectangle of maximum area

2303. *Proposed by the Editor.*

In triangle $P_1P_2P_3$, r is radius of incircle, r_1, r_2, r_3 are radii of excircles inside angles P_1, P_2 and P_3 respectively, show that

$$r = s\left(\tan\frac{P_1}{2}\tan\frac{P_2}{2}\tan\frac{P_3}{2}\right)$$

when $2s$ is perimeter of triangle $P_1P_2P_3$. This relation appears in problem 2279.

2304. *Proposed by V. C. Bailey, Evansville, Ind.*

Prove that

$$1-1/7+1/9-1/15+1/17-1/23+1/25-\cdots = \frac{\pi(\sqrt{2}+1)}{8}.$$

In our February issue the address of Janice A. Egeland should have read Red Bank High School, Red Bank, New Jersey.

THE NAM'S SUPPORT OF EDUCATION

"Business enterprises must find a way to support the whole educational program effectively, regularly—and *now*."

With this resolution, the National Association of Manufacturers has launched an unprecedented, nation-wide campaign to get businessmen to come to the financial aid of America's public and private schools.

The NAM's campaign, which has the approval of leaders in education, the professions, and in industry, was announced by Earl Bunting, managing director. In letters to the more than 17,000 members of the association, Mr. Bunting asked each to take the lead in a drive to aid both public and private schools in his own community and also "to arouse other businessmen to do their part."

Mr. Bunting's appeal revealed that the NAM, which for years has voiced industry's interest in education, has now gone further and is urging business enterprises to assume a larger and more concrete responsibility for the financial support of education.

The association took this new position because influential leaders in industry and business were concerned over relative "freeze" in funds available for education at the very time when educational needs were expanding and educational costs were mounting even more rapidly.

It was pointed out that the progressive rate principle in income taxes has halted the building of private fortunes, which once formed the source of large endowments and other bequests to education.

At the same time, Federal taxes are taking more and more of the income earned in each community and state, leaving less money available for education and other needs. Compounding these forces has been inflation, which, by halving the value of the dollar, doubled the need for dollars just to maintain existing faculties, facilities, and standards.

This squeeze of economic forces, which threatens the very existence of many institutions of higher learning, and is weakening all education, formed the background for the NAM's decision to act.

BOOKS AND PAMPHLETS RECEIVED

TEXTBOOK OF ORGANIC CHEMISTRY, Third Edition, by George Holmes Richter, *Dean of The Rice Institute and Professor of Organic Chemistry.* Cloth. Pages vii+762. 14.5×23 cm. 1952. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $6.75.

PRINCIPLES OF RADIO, Sixth Edition, by Keith Henney, *Consulting Editor, "Electronics," Fellow, Institute of Radio Engineers,* and Glen A. Richardson, *Assistant Professor of Electrical Engineering,* Iowa State College. Cloth. Pages vii+655. 13.5×21.5 cm. 1952. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $5.50.

A HISTORY OF THE THEORIES OF AETHER AND ELECTRICITY, by Sir Edmund Whittaker, F.R.S., *Honorary Fellow of Trinity College, Cambridge.* Cloth. Pages xiv+434. 15×23.5 cm. 1951. The Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $12.00.

SPEECH TRAINING, A HANDBOOK FOR STUDENTS, by A. Musgrave Horner, *Lecturer on Speech Training, Stranmillis Training College, Belfast.* Cloth. 176 pages. 12.5×20 cm. 1951. The Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $3.75.

THE PRINCIPLES OF GENERAL BIOLOGY, by Mary S. Gardiner, Ph.D., *Professor of Biology, Bryn Mawr College.* Cloth. Pages xvi+657. 16.5×24.5 cm. 1952. The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y. Price $5.25.

RADIO AND TELEVISION RECEIVER TROUBLESHOOTING AND REPAIR, by Alfred A. Ghirardi, *Author, Radio Physics Course, Modern Radio Servicing, Radio Troubleshooter's Handbook;* and J. Richard Johnson, *Co-Author, Practical Television Servicing, Radio and Television Receiver Circuitry and Operation.* Cloth. Pages xxiv+822. 15×23 cm. 1952. Rinehart Books, Inc., 232 Madison Avenue, New York 16, N. Y. Price $6.75.

METHODS AND MATERIALS FOR TEACHING GENERAL AND PHYSICAL SCIENCE, by John S. Richardson and G. P. Cahoon of *The Department of Education, The Ohio State University.* Cloth. Pages viii+485. 14.5×23 cm. 1951. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, N. Y.

SECOND ALGEBRA, by Virgil S. Mallory, *Professor of Mathematics and Instructor in the College High School, State Teachers College, Montclair, New Jersey;* and Kenneth C. Skeen, *Head of the Department of Mathematics, Union High School and Junior College, Taft, California.* Cloth. Pages vii+480. 13×20.5 cm. 1952. Benj. H. Sanborn and Company, 221 East 20th Street, Chicago 16, Ill.

TRIGONOMETRY PLANE AND SPHERICAL WITH TABLES, by Lloyd L. Smail, Ph.D., *Professor of Mathematics, Lehigh University.* Cloth. Pages xii+406. 14.5×23 cm. 1952. McGraw-Hill Book Company, Inc., 330 West 42nd Street, New York 36, N. Y. Price $3.75.

ELECTRICAL COMMUNICATIONS EXPERIMENTS, by Henry R. Reed, Ph.D., *Professor of Electrical Engineering;* T. C. Gordon Wagner, Ph.D., *Associate Professor of Electrical Engineering;* and George F. Corcoran, M.S., *Professor and Chairman, Electrical Engineering Department, all at the University of Maryland.* Cloth. Pages viii+458. 14.5×23 cm. 1952. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $6.75.

GENERAL BIOLOGY, Fourth Edition, by James Watt Mavor, Ph.D., *Professor Emeritus of Biology in Union College, Schenectady, New York.* Cloth. Pages xiii+875. 14.5×23 cm. 1952. The Macmillan Company, 60 Fifth Avenue, New York 11, N. Y. Price $5.75.

LIGHTNING AND THUNDER, by Herbert S. Zim. Cloth. 64 pages. 16.5×20.5 cm. 1952. William Morrow and Company, Inc., 524 Fourth Avenue, New York 16. N. Y. Price $2.00.

BUSINESS MATHEMATICS, by Walter F. Cassidy and C. Carl Robusto, *St. John's University, Brooklyn, New York.* Cloth. Pages vii+304+109. 14×21.5 cm. 1952. Prentice-Hall, Inc., 70 Fifth Avenue, New York, N. Y. Price $4.75.

THE DESIGN AND ANALYSIS OF EXPERIMENTS, by Oscar Kempthorne, *Professor*

of Statistics, Iowa State College. Cloth. Pages xix+631. 14×23 cm. 1952. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $8.50.

MATHEMATICS IN ACTION, Books 1, 2, 3, by Walter W. Hart and Lora D. Jahn. Third Edition. Cloth. 13×20 cm. Book 1, Pages xi+324. Price $2.12. Book 2, Pages vii+294. Price $2.24. Book 3, Pages viii+354. Price $2.40.

HOW TO PASS RADIO LICENSE EXAMINATIONS, by Charles E. Drew. Third Edition. Paper. 367 pages. 15.5×23.5 cm. 1952. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $4.50.

PHYSICS LABORATORY MANUAL, by Clifford N. Wall, Ph.D., *Professor of Physics, University of Minnesota,* and Raphael B. Levine, Ph.D., *Research Associate in Biophysics, University of Minnesota.* Paper. Pages viii+232. 21×28 cm. 1951. Prentice-Hall, Inc., 70 Fifth Avenue, New York 11, N. Y. Price $3.75.

THE PRINCIPLE OF RELATIVITY, A COLLECTION OF ORIGINAL MEMOIRS ON THE SPECIAL AND GENERAL THEORY OF RELATIVITY, by H. A. Lorentz, A. Einstein, H. Minkowski and H. Weyl. Paper. Pages viii+216. 13×20.5 cm. First Published in 1923. Dover Publications, Inc., 1780 Broadway, New York 19, N. Y. Price Paperbound, $1.50, Cloth, $3.50.

EDUCATION AND NATIONAL SECURITY, by the Educational Policies Commission of the National Education Association of the United States and the American Association of School Administrators, and the Executive Committee of the American Council on Education. Paper. Pages v+60. 15×23 cm. December 1951. National Education Association, 1201 Sixteenth Street, N.W., Washington 6, D. C. Price Single Copies 50 cents.

ELECTRIC EYE ON EAR TELLS PILOT'S OXYGEN LACK

A device to end a pilot's worries about lack of oxygen has been developed by Dr. Kurt Kramer, physiologist at the U. S. Air Force School of Aviation Medicine, Randolph Field.

The pilot wears a tiny, earring-like device attached to either ear. Using the tiny button, connected by wire to the plane's instrument panel, he will be warned promptly when his oxygen supply is leaking or if his hose has become disconnected.

Operating on an electric eye principle, the warning device uses the ear lobe as a light filter. It is activated by the slightest change in the oxygen content of the blood, since blood lacking in oxygen changes to dark red. Ordinarily it is difficult or impossible to detect such an oxygen lack.

The photoelectric eye detects the blood's color change and instantly a red light flashes brightly on the instrument panel, warning the pilot of impending danger and of the possibility of passing out.

Dr. Kramer's invention may also prove useful outside the field of aviation. A doctor could thus control the amount of oxygen given to patients, the warning red flash telling him that artificial respiration is necessary. It may even be a boon for those suffering from respiratory paralysis, particularly polio, the German-born doctor states.

THE USE OF DRAIN TILE

The use of tile drains is most common in the Corn Belt states of Iowa, Indiana, and Ohio. They have more miles of tile drains than the total of all the other 37 states. The only other state with a sizeable amount of tile drains is Minnesota.

Indiana has the greatest mileage of drainage works of all kinds, of any state, followed in order by Ohio and Michigan. These same states also have the greatest mileage of open ditches. Iowa, Indiana, and Ohio lead all states in miles of tile drains. California, Illinois, and Missouri have the most miles of levees and dikes.

BOOK REVIEWS

METHODS AND MATERIALS FOR TEACHING GENERAL AND PHYSICAL SCIENCE, by John S. Richardson and G. P. Cahoon of *The Department of Education, The Ohio State University.* Cloth. Pages viii+485. 14.5×23 cm. 1951. McGraw-Hill Book Company, Inc., 330 W. 42nd Street, New York 36, N. Y.

This is a book which should be on the desk of every teacher of physical science in the entire country. Although it professes to cover only one part of the course of science instruction no science teacher will follow it without at the same time absorbing much of the entire training course. It is made up of two sections. The first, "Laboratory Experiences for Science Teaching," makes up about 40% of the book. The authors first attack the problem of planning how to use the materials and apparatus to insure successful teaching results. Every phase of correct teaching is well discussed: learning to do by doing, meaningful principles and application, critical thinking, initiative and resourcefulness, cooperation with others, individual differences. Demonstrations, group projects, field trips are discussed as only experts can. Chapter 2 masterly discusses the demonstration experiment, giving excellent instruction on how to make it easily seen by all class members. Instruction for individual and small group laboratory work follows. Student projects and reports with an excellent short list of projects, how to plan and carry out field trips, and how to teach pupils to really think through laboratory exercises follow next. The use of visual and auditory aids such as movies and slides make up a remarkable chapter. Here is found a number of illustrations showing how to set up projectors for the many demonstrations that make the minute things visible to an entire class. Chapter 7 contains many things which often stump the teacher, including the use of AC or DC when only the one source is available, with instructions for making up rectifiers, transformers, furnaces for minor use, electric arcs, low pressure apparatus, etc. The final chapter of this section gives the source of the tools and supplies with important shop instructions for the care and repair of instruments and for making and setting up minor equipment.

The remainder of the book, nearly 300 pages, is used in describing a vast number of experiments gleaned from many sources and used in the teaching of physical science. Diagrams are used copiously to illustrate and clarify the discussions. One thorough reading will enable the student or teacher to get most of the first section of the book but the second section must like a dictionary be open on the desk constantly.

Many excellent references are cited throughout the book. Here we find the most frequent are the fifty years of SCHOOL SCIENCE AND MATHEMATICS and Sutton's *Demonstration Experiments in Physics.* A short list of excellent books and periodicals is given in the appendix. If your department or school library does not contain a copy of this book it is time to order from one to a dozen or more copies depending on the size of your school.

G. W. W.

NORTH OF THE CIRCLE, by Frank Illingworth. Cloth. 254 pages. 13.5×21.5 cm. 1951. The Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $4.75.

When the United States bought the territory of Alaska from the Czarist government of Russia in 1867 many politicians and economists here complained because $7,200,000 was spent for that land of snow and ice. Now it is a wealthy territory, producing grains, vegetables, sheep and cattle in addition to great fish and fur industries and its untold mineral wealth. It now has a mission in Washington clamoring for statehood and is our most important and closest route to the orient. The polar region, just a few years ago considered a closed section and scarcely worth exploration is now a region of constant study by our air and weather men, and is our nearest route to much of Europe and Asia. Canada, Greenland, and all northern Europe and Asia are fast becoming similar regions

for colonization and the source of some of our most needed minerals.

The author, Mr. Illingworth, has spent many years traveling over all this territory except through the vast region under control of the USSR. He gives vivid pictures of the life of the inhabitants, their occupations, their pleasures, their hardships—and the diseases, many of which were unknown before the explorers and traders from the south arrived. He also gives some of the trials of the doctors who make the long sledge trips to distant lonely trapper ice huts beyond the Circle. Pleasures, hardships, industries, schools, explorations, military operations, are all told in this interesting little book. The English professor will find many errors in language, but the average reader will gladly pass them in following the interesting, inspiring, and highly useful story. Many excellent photographs add interest and help to display the life of the people and animals of the Arctic.

G. W. W.

REFERENCE BOOK OF INORGANIC CHEMISTRY, by Wendell M. Latimer and Joel H. Hildebrand, both *Professors of Chemistry at the University of California.* Cloth. Pages xii+625. 13.5×21.5 cm. 1951. The Macmillan Company, New York. Price $5.00.

This is the third edition of a well known and widely used reference text in inorganic chemistry. It was first printed in 1928; such a book requires no lengthy review.

The first three chapters treat in order hydrogen, the inert gases, and oxygen. Then follow eighteen chapters each giving a thorough description of the chemistry of the elements of either a group or a subgroup of the periodic table. Chapter twenty-one, The Actimide Elements, and chapter twenty-two, Nuclear Reactions, are entirely new and bring the reference up to date. The recently discovered and artificially produced transuranium elements are described. Even the recently prepared berkelium and californium are given brief paragraphs.

Brief additions are found to the earlier written chapters; the chapter on silicon has four paragraphs explaining some of the chemistry of silicones.

Finally let me emphasize that this is not a textbook but a single reference to which a chemist may go to find needed information concerning the elements and their compounds. The freshman student in chemistry could get useful information from this reference. It should be on the reference shelf of any advanced course in inorganic chemistry.

GERALD OSBORN
Western Michigan College of Education
Kalamazoo, Michigan

SPINOZA DICTIONARY, Edited by Dagobert D. Runes. With a Foreword by Albert Einstein. 309 pages. Philosophical Library 1951. $5.00.

This is essentially a technical volume on Spinoza, appropriate, in the largest sense, to the professional philosopher's study, and to other academicians who find occasion to "talk Spinoza." It is a dictionary of terms, a handbook of words, phrases, concepts, et cetera, as Spinoza used them. For a scholar engaged in Spinoza this collection would have substantial value.

For the lay reader, the "Foreword" by Einstein and the "By Way of Introduction" by the author are by far the most valuable features. Einstein's recitation of about a page points up nicely the single fact of which students of philosophy must be aware: *what did the philosopher mean?* (It was to avoid this hazard in interpretation that the volume on Einstein was brought out by The Library of Living Philosophers, while Einstein still lives. Anyone who has not seen this classic should seek it out at once—and own it!) The introduction is highly readable and very informative, historically and otherwise. The proper study of a philosopher lies first in the social, religious, ethical, economic scene which precedes and envelops his own era. These few pages point up the picture very well.

The book is rather expensive—but what more lasting than a good book can five dollars buy?

JULIUS SUMNER MILLER
Dillard University
New Orleans 22, Louisiana

LOGIC FOR LIVING—Dialogues from the Classroom of Henry Horace Williams. Edited by Jane Ross Hammer. 281 pages. Philosophical Library 1951. $3.75.

Professor Henry Horace Williams taught at Chapel Hill for half a century. He lived simply and left his life savings of some $50,000 for the provision of fellowships for students in philosophy. This volume is a tribute to him. It is a collection of his classroom words—his lectures, his dialogues, his questioning, his argument. He was of the old school—the kind of teacher we think of in connection with the log—you know, the teacher on one end, the student on the other.

"Horace Williams did possess unusual characteristics which could attract and inspire young people. Beyond a keen and fearless mind, he had also a sense of timing and imagery that approached the dramatic. His classes were for decades the most discussed on the campus, in spite of his known rule of giving A's only in the most exceptional cases. His sense of humor was sharp and his tongue often merciless when aimed at shallowness of thought, either in general or in particular individuals. His frankness made bitter enemies as well as ardent friends. However, his eccentricities seemed to emphasize to the student that only two things were really important: The task of education is to know yourself, and knowledge, like life, is a process of development."

His influence upon students must have been phenomenal and like all such teachers his influence went beyond the classroom.

This record of his classroom sessions (Lectures of 1921–22) is nicely done. The class discussions refer by name to actual members of the class. In a few instances the names are fictional.

For those of us who had teachers like this, and I had a goodly number of this calibre, this book contains much personal reminiscing. I can remember my own teachers of a quarter century ago saying things just like this. Let's look at a few samples. Professor Williams speaks:

"A man in class said the other day that he was taking this course because he was planning to be a lawyer and he wanted to know how to ask questions, not how to answer them."

"Sometimes, in order to wake up an individual and get his mind going, it is necessary to confuse him."

" . . . I never call the roll on my students at Chapel Hill. . . . Everybody is present. I do not need to call the roll. . . . The Honor System begins with the professor. It is his business to make the hour worthwhile, for then the student will probably attend class. I regard it my simple duty to meet you at every class period, for I deny the right of a college professor to cut a class. To me it is a moral matter. . . . "

"I would like to say a few things about the examination before I close the lecture. I am quite sure you do not endorse what I did with your records. Usually people do not like low grades, and I like to please people, so it makes me unhappy. When a paper strikes me as being unacceptable, I have never worked out any way of reporting that it is acceptable."

I am glad I discovered this book.

JULIUS SUMNER MILLER

CAREERS IN PHYSICS, by Alpheus W. Smith, *Professor of Physics, Emeritus, and Dean Emeritus of the Graduate School, The Ohio State University*. 271 pages. Long's College Book Company, Columbus, Ohio. 1951. $4.00.

The title of this book is self-explanatory, and Professor Smith points up its ambition in his Foreword:

"It is the purpose of this little book to outline briefly the meaning and scope

of modern physics, to indicate some of the professional activities in which physicists engage, and to give high school and college students and teachers of physics a better understanding of physics as a profession. . . . "

This book should serve a large variety of people, and more especially two classes: those who are students and who would like to focus on their life's work; citizens who would like to know what physicists do. For the first, we find students often quite unfamiliar with what their plans for a living embrace. If they contemplate physics, this book discusses nearly every facet of that drama. For the citizen, the word physicist conjures up the image of an ogre who has made the world impossible to live in! Years ago the citizen of average literacy had no notion whatsoever of what a physicist does or what physics is. He knew what a chemist was pretty well—a white-frocked professor in a room cluttered with test tubes and bottles and gas burners—enveloped in frightful odors! But he never clearly knew what a physicist was. The Second Great War has cleared up *that* misconception. But it has also given the citizen another distorted picture which needs clearing up. This book does it.

Professor Smith writes interestingly and accurately. The few photographs are very good, but there could have been more. An appendix gives a representative list of industrial research laboratories employing physicists.

Physics professors would do well to have this book on the desk for students to browse through.

JULIUS SUMNER MILLER

FINITE MATRICES, by W. L. Ferrar, M.A., D.Sc., *Fellow of Hertford College, Oxford, England.* Cloth. Pages v+182. 13.5×22 cm. Oxford University Press, 114 Fifth Avenue, New York 11, N. Y. Price $4.00.

This book will be of primary value to the student who wishes to carry his knowledge of matrix theory beyond what is found in the usual first textbook in the subject—or the material found in a text in advanced or modern algebra. The introductory chapter gives a rapid review of some of that material. The general scope of the material is indicated by chapter titles: Equivalent Matrices; Equivalent Lambda Matrices; Collineation; Infinite Series and Functions of Matrices; Congruence; Matrix Equations. Much of the material has heretofore not appeared in any connected form. The high standard of writing shown in previous books by this author (and by this publisher) is continued. The index is not as complete as might be (example, the *scalar equations* entry omits the reference on page 154). A considerable amount of mathematical maturity is needed to follow the text. As might be expected, there are no sets of examples There seems to be no other book in the field covering just this type of material.

CECIL B. READ
University of Wichita

TENSOR ANALYSIS, THEORY AND APPLICATIONS, by I. S. Sokolnikoff, *Professor of Mathematics, University of California, Los Angeles.* Cloth. Pages ix+335. 14.5×23 cm. 1951. John Wiley and Sons, Inc., 440 Fourth Avenue, New York 16, N. Y. Price $6.00.

Although this book is probably planned as a textbook for a graduate course in this mathematical subject, it contains a great deal of valuable reference material and will from that point of view be of interest to applied mathematicians, physicists, and engineers. A considerable amount of mathematical maturity will be required to read the book. As indicated, the book will probably find its place as a graduate text or in university libraries as a reference work.

The first chapter, which to many readers will be review material, is exceptionally well written, and should not be skipped, for it leads one through concepts needed in later chapters. The author makes a very important point of his development of the treatment of tensors as self-contained, rather than dependent upon geometry or relativity. After this development, he proceeds to applications—the first topic being geometric. In this chapter one encounters much of classical

differential geometry. Applications to mechanics, both classical and relativistic, occupy about one third of the text. The general standard of writing is high, which might be expected from an author of several advanced mathematics texts which have stood the test of time. There are occasional short lists of problems.

CECIL B. READ

PHILOSOPHICAL PROBLEMS OF MATHEMATICS, by Bruno Baron v. Freytag, *Lecturer on Philosophy, University of Tübingen.* Translated from the German by Amethe Countess von Zeppelin. Cloth. 88 pages. 13.5×21 cm. 1951. The Philosophical Library, Inc., 15 East 40th Street, New York 16, N. Y. Price $2.75.

The philosopher will need some mathematical knowledge to read this book, the mathematician should have a good background of philosophy. This is definitely not a book for the high school student—few undergraduates will follow it with any ease. The person who wishes to think *about* mathematics will find it stimulating. For example, the quotation: "Mathematics is a science of pure ideas—perhaps the only one." To illustrate some of the material covered, one might mention the discussion of what is meant by the existence of a mathematical object; the applicability of mathematics to reality; why such concepts as ethics and religion have remained inaccessible to mathematical treatment. Again, the author discusses the questions: How is mathematics itself affected by the fact that it is studied and practiced by human beings, and to what extent is its form dependent or independent of this factor? For anyone interested in such philosophical problems, this book will provide an excellent introduction.

CECIL B. READ

HOW TO STUDY, HOW TO SOLVE—ARITHMETIC THROUGH CALCULUS, by H. M. Dadourian, *Seabury Professor of Mathematics and Natural Philosophy (Emeritus), Trinity College.* Paper. Pages vi+121. 11.5×17 cm. 1951. Addison-Wesley Press, Inc., Kendall Square, Cambridge 42, Mass. Price $1.00.

This little book, written for the student, should be of value to all students, but particularly the one who feels that he personally simply cannot grasp mathematics. The first part of the book, twenty-five pages, is concerned with the problem of how to study, and discusses such ideas as incentive, interest, self-confidence, and the will to learn. The second portion deals with problem solving, and gives definite directions as to methods of procedure which will avoid common difficulties. This is accompanied by illustrative problems, in which the general directions are applied. Part III—Arithmetic through Calculus—supplements and expands some of the material in the second part, gives some frequently used formulas and theorems, and in several cases points out which of several optional procedures is likely to be most fruitful.

Not every teacher will agree with all that the book states. The reviewer, for example, objects to the use of different scales on the two axes in graphing the trigonometric curves (pp. 78–79) because it may cause the student difficulty in certain problems. He likewise does not agree with the author that it is better to use a single letter, such as s, for a distance, rather than the endpoints of the line segment, such as AB; to illustrate, although it is granted that the "horrible example" of the proof of the formula for the sine of the sum of two angles (pp. 44–47) is indeed bad; the suggested improvement has the fault that the student may lose sight of the fact that the line segments involved are directed lines (unless all angles are acute, and preferably so even then). In spite of points such as these, the book has a wealth of material which should be exceptionally valuable to the student. Particularly helpful are suggestions that any results be checked for reasonableness by use of plain common sense; checking of derived formulas by substitution of special values which will reduce the general formula to a special case where the result is known; and the emphasis on the fact that an equation should be *dimensionally correct.*

A copy of this book should be available not only in the school library, but also

in mathematics classrooms of all high schools and colleges. Teacher as well as students will profit by reading and heeding the material.

CECIL B. READ

ANALYTIC GEOMETRY AND CALCULUS, by William R. Longley, *Yale University;* Percy F. Smith, *Yale University;* and Wallace A. Wilson, *Late Professor of Mathematics, Yale University.* Cloth. Pages ix+578+xx. 15×23 cm. 1951. Ginn and Company, Statler Building, Boston 17, Mass. Price $5.00.

This book is one of several texts which have appeared in the past few years, presenting the material as a combined course, so the student may make use of his calculus early in his college career. Any generalization is unfair, but it seems to the reviewer that this text has the same fault that many similar books have—it appears to have been compiled by taking a chapter or two from an analytics text, then one from differential calculus, another from the analytics, etc., rather than a complete unification of the subjects. There are many points at which use of the calculus appears in a chapter primarily analytic geometry, but even then at many points it seems as though it was a mere placing of some calculus problems at this particular position.

The first two chapters, pure analytics, cover the straight line and curve tracing. The treatment is essentially traditional except for an unusual treatment of the distance from a point to a line—the normal form of the equation of a line is not mentioned. This reviewer would prefer the statement that a vertical line has no slope rather than that its slope is infinite (the statement apparently contradicting a good treatment on page 3).

Contrary to some texts, which treat integration and differentiation of algebraic polynomials first, this book covers differentiation of general algebraic functions, then treats rates and differentials. Problems involving maxima and minima are left until after integration is introduced and applied to such concepts as length, area, and volume—the treatment including simple change of variable methods in integration. After treating maxima and minima, the conics are introduced.

The figure 88.4 seems poorly drawn; there seems to be no reason why in the discussion of symmetry a test would not be given which would also apply to non-algebraic functions, but these are minor flaws. The treatment of boundary curves is unusually good; there is an excellent example (p. 198) of a function which has a practical meaning, yet has a point at which the right hand and left hand derivatives are unequal; the chapter on series has good illustrations of application to actual problems as a means of approximation.

As might be expected, the treatment follows the lines of previous books by the authors, which have stood the test of time. There is an abundance of material, most teachers will probably need to make some omissions. The supply of problems seems ample, there are answers to selected exercises, there seems to be no particular pattern in selecting the ones to which answers are given. The final chapter contains formulas from previous courses, an extensive integral table, and the usual numerical tables.

CECIL B. READ

SCIENCE FOR MODERN LIVING SERIES, Books 7, 8, and 9, by Victor C. Smith, *Department of General Science, Romsey Junior High School, Minneapolis, Minn.*, and W. E. Jones, *Chairman, Biology Dept., Evanston Township High School, Evanston, Ill.* in consultation with W. R. Tieters, *Director of Education, St. Louis Public Schools, St. Louis, Mo.* Book 7, "Exploring Modern Science," 332 pages; Book 8, "Enjoying Modern Science," 443 pages; Book 9, "Using Modern Science," 618 pages. J. B. Lippincott, 1951.

Science for Modern Living, Books 7, 8, and 9 are an extension of the elementary school series prepared by Victor C. Smith and others and are written for use by seventh, eighth and nineth grade pupils. This series of Junior High School series makes for a well planned nine year sequence in science.

Book 7, "Exploring Modern Science," includes six units: air, water, astronomy,

the earth, health, fire and heat, weather, plants and animals, and conservation.

Book 8, "Enjoying Modern Science," includes six units: energy, health, the earth, consumer education, climate and atmosphere, and plants and animals.

Book 9, "Using Modern Science," includes six units: conservation, energy, health, plants and animals, machines, and transportation and communication.

It is noted that in each book the content is planned around large areas of investigation. The unit titles are somewhat misleading since one could easily conclude from these that there is much meaningless repetition. This is not true in any respect because each book includes new scientific generalizations which add to the pupils' understanding of the areas.

The books are written in a style which makes for easy and fluent reading at all three levels. The authors have been cognizant of different reading abilities possessed by seventh, eighth and nineth grade pupils. In addition to the well developed narrative portions of the texts they have the added features of excellent illustrations and well described demonstrations and experiments.

Probably the most outstanding feature of this series of science texts is the way in which content is made meaningful to the pupils. Most topics are introduced with a meaningful problem and end with socially significant applications. The social implications of science in the lives of boys and girls as well as adults is paramount in the presentation of each of the units.

MILTON O. PELLA
University of Wisconsin

SECONDARY MATHEMATICS, by Howard F. Fehr, *Professor of Mathematics, Teachers College, Columbia University, New York.* Cloth. Pages xi+431. 14.5×22.5 cm. 1951. D. C. Heath and Company, 285 Columbus Avenue, Boston 16, Mass. Price $4.25.

Not only teachers and prospective teachers of secondary school mathematics but any person who has had the usual introductory courses in trigonometry, solid geometry, college algebra, analytic geometry, and elementary calculus will enjoy this book.

It is arranged so that it may be used as a textbook in connection with teacher training. However, it is not primarily concerned with methods of teaching. It provides, rather, a background for the teacher of secondary mathematics by selecting topics from advanced mathematics courses and presenting them in such a way as to provide a better understanding by the teacher of the subject matter he will or does teach. Mentioning a few of the nineteen chapter titles may help to illustrate this fact: "A Functional Approach to Geometry," "Linear and Quadratic Functions," "Loci and the Conic Sections," "The Number Concept," "Integration."

Some material in the book may be used directly in the secondary school class room and much may be used at this level with students of above average ability.

The language of the book is scholarly but explanations are adequate. Valuable references are listed at the conclusion of each chapter and at the end of the book.

The fact that the material in the book has actually been used in teacher training classes and found effective should make the book particularly acceptable as a text for prospective teachers.

Mathematics teachers with a rich background in advanced mathematics will find the book a refreshing review; those with a more limited background will find that they can get much from this book which otherwise would require the study of many courses in advanced mathematics. All mathematics teachers will want the book on their desk for ready reference. Professional libraries which serve one school or an entire school system will desire to make it available to the teachers they serve.

MARIE S. WILCOX
George Washington High School
Indianapolis, Indiana

MAKING MATHEMATICS WORK, by Gilbert D. Nelson, *Chairman of the Mathematics Department at Lincoln High School, Cleveland, Ohio;* Herschel E. Grime, *Directing Supervisor of Mathematics for the Cleveland Public Schools;* and assisted by Fred N. Burroughs, *Chairman of the Department of Mathematics, John Adams High School, Cleveland, Ohio.* Cloth. Pages x+630, 15.5×22 cm. Houghton Mifflin, Boston, 1950.

This is a new and practical textbook in general mathematics which is intended for use by non-academic high school students and in which the subject matter is presented in a very readable and interesting manner. Unit I presents a thorough review of the fundamentals of arithmetic. Unit II deals with real-life problems of earning and managing money. It includes such topics as earning money, accounts and budgets, spending money wisely, household bills, and checks and money orders. Unit III is concerned with real problems related to the investment of money, insurance for security, and borrowing money. Unit IV deals with similar problems regarding shelter, travel and taxes, while the fifth and final unit includes an introduction to such mathematical tools as statistics, algebra and geometry. Each of these units covers from two to five of the sixteen chapters in the text. Each chapter is concluded with a brief summary of what has been learned in the chapter and a comprehensive review test covering the topics studied. The maintenance of arithmetic skills is accomplished by means of extensive checkup tests on computation presented at the end of each of the five units.

The book contains approximately 2,500 exercises and almost 1,000 problems. Problem lists are preceded by appropriate examples in which the pupil is shown "what to do" and "how to do it" in a simple and direct manner. The text appears to be very well organized and is set up in an attractive format. Well chosen diagrams, line drawings and photographs appear at appropriate places throughout the book. A number of cartoons aid in attracting the interest of the pupil. Some thirty-six tables of various kinds are found at suitable points throughout the book. The materials presented should be more than ample for a full year's work in general mathematics at the ninth grade level.

JAMES B. MAUS
Lyons Township High School
La Grange, Illinois

MATHEMATICS IN DAILY USE, by Walter W. Hart, *author of Mathematics Texts;* Cottell Gregory, *Louisville Girls High School, Louisville, Kentucky;* and Veryl Schult, *Supervisor of Mathematics, Divisions I–IX, Washington, D. C.* Revised Edition. Cloth. Pages viii+376, 14×20.5 cm. D. C. Heath & Company, Boston, 1950.

Both the first edition and this revised edition of this ninth grade text present a course in general mathematics that is designed either for those pupils for whom algebra will not be a profitable study or for those pupils who have definite weaknesses in mathematics, but who will study algebra later. The primary purpose of the authors has been to create appreciation of the existence of mathematical problems in every day life and to develop the understandings and the skills that are needed to solve these problems. By studying the real-life problems relating to activities of leisure time, home life, community life and business life presented in this text the pupil becomes more aware of the importance of mathematics in his every-day life and tends to develop a desire to study other courses in the field. It is the hope of the authors that some students, by studying this book, may for the first time in their lives become convinced that they have the ability to master mathematics. The interesting presentation and simple explanation might well lead to the realization of this hope.

The text presents thorough instruction of the fundamentals of arithmetic, but on a somewhat higher level than similar instruction in the lower grades. It also includes work with graphs, formulas, and simple topics of algebra. The vocabulary and sentence structure used throughout the text are so direct and simple

that they make it very readable and well adapted to the pupils for whom the course is intended. There are numerous practice exercises and problems, and a systematic reviewing and testing program. Diagnostic tests usually precede instruction; each chapter is concluded with a mastery test; and frequent review tests help toward the maintenance of skills previously learned. The book is concluded with a series of short tests covering the work of the entire course.

In the revised edition the work on statistics and graphs has been brought up to date and new information on income tax and social security has been included.

JAMES B. MAUS

EVERYDAY ALGEBRA, Intermediate Course, by William Betz, *Specialist in Mathematics, Rochester, New York*, and Alfred P. Windt, *Hempstead High School, Hempstead, Long Island, New York*. Cloth. Pages x+566. 14×20.5 cm. 1951. Ginn and Company, Statler Building, Boston 17, Mass. Price $2.48

As the title implies the text is intended for use in a second course in Algebra. The topics covered are those commonly included in Intermediate Algebra courses through logarithms, arithmetical and geometrical progressions, binomial expansion, and trigonometry. Slope intercept and point slope graphing are included but determinants are omitted. Several not-so-common items that appear in this text are: (1) a rather thorough discussion of problem solving by the graphic approach (2) approximate computation and significant figures (3) a fairly lengthy discussion on the slide rule and its uses, and (4) an extension of Trigonometry to include the Law of Sines and Law of Cosines.

The text may be used for either a one-semester or two-semester course. The authors give the teacher a table of time allotments for the various units for both the one and two-semester courses. The approach to Algebra in the chapters of the first unit is very elementary. The authors state that the first unit and maybe parts of the second unit could be omitted by students who have studied first year algebra recently.

The authors have attempted to give systematic attention to the basic concepts and principles of Algebra. This is typified in the graphical explanation of the laws of order, laws of grouping, and laws of distribution. It is also evident in the rules of equality used as a basis for the solution of equations. Understanding is also stressed in the discussion on introducing or losing roots in an equation. The geometric explanation of extracting square root makes the topic meaningful to the student. These illustrations indicate the method of approach used by the authors on other topics. Prominence is given to the study of relationships and hence to "functional thinking." The functional notation is explained.

Sets of motivating discussions are interspersed in various parts of the text. Also many informative sketches having to do with the role of mathematics in the modern world are included. The problem material for most topics is ample although it seems that additional applications in direct and inverse variation might have been included. The text as a whole leads the student gradually from the elementary topics of algebra to the more advanced ones, and has a variety of materials from which to choose topics for study.

REINO M. TAKALA
Oak Park-River Forest High School
Oak Park, Ill.

A connector for attaching a garden hose to a faucet is made of cellulose acetate butyrate. One part, with inside threads, screws directly on the faucet, and the other part, with outside threads, screws into the receiving end of the hose. A quick half-turn attaches the hose to the faucet and releases it. If you want more information, send a three-cent stamp to Science Service, 1719 N St., N.W., Washington 6, D. C., and ask for Gadget Bulletin 612.